MANUAL OF ARCHAEOLOGICAL SURVEYING

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Archaeology: Vol. II

Manual of ARCHAEOLOGICAL SURVEYING

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DEDICATION

This Manual is dedicated to the Directors of the various expeditions with whom I had the privilege of working from 1930 to 1937 in the Near East. Much of what is written here I have learned from them.

I would like to mention in particular the late Dr. Clarence S. Fisher, my first teacher in practical field archaeology. He always meant to write such a manual, and I am sure he would have approved the idea if not all the contents.

FOREWORD

It has long been taken for granted by competent archaeologists that all systematic excavation must be preceded and followed by careful surveying of the terrain which is being dug. Whether a professional surveyor does the work or not, it must be done. The first questions asked by an archaeologist when he opens a publication by a colleague are: How accurate are his surveys? — Can I rely on his plans and levels? Moreover, archaeological surveying is fast becoming a specialized subject, in which considerable practical experience in field work is required before satisfactory results can safely be expected. Stratigraphic surveying is something of an art by its own right, and neither the surveyor nor the architect is prepared by theoretical grounding or actual experience for the peculiar difficulties with which it confronts the excavator.

A compact manual of archaeological surveying has long been needed, in order to enable excavator, surveyor and architect to meet on common ground from the beginning. Every professional archaeologist should master enough surveying and enough architecture to enable him to utilize the special knowledge of the technical members of his staff to the fullest advantage, even if he remains unable to take their places himself. Every architect working in the archaeological field should know enough about stratigraphy and other important phases of archaeology to grasp the meaning of his own observations. If the architect lacks practical experience in surveying he may need advice as to how best to proceed in a given situation—advice which he will not find in a textbook of surveying.

When Professor Detweiler mentioned his plan for writing a manual of archaeological surveying to me several years ago, I was enthusiastic about the idea, knowing how much loss of time and effort a good manual of this kind would have saved me in my early years of excavation. Now that I have seen the completed manuscript I am more enthusiastic than ever. It is just what is needed to bridge the gap between surveyors, architects, and excavators, and to save labor and avert misunderstandings in future excavation. To be sure, this manual will not take the place of a course in surveying or of practical experience, but it will supplement them in the most useful way.

Few archaeologists are so well equipped by training and experience to write a manual of this kind as Professor Detweiler. Thanks to his many years of preparation as a student of architecture at the University of Pennsylvania, as draughtsman and surveyor, as architect at-

tached to many expeditions in Palestine, Syria and Mesopotamia, as teacher of the history of architecture at Cornell University, he has a unique grasp of the subject and an unequalled appreciation of the practical questions which arise in connection with excavations of varied character. Few architects have worked with so many different archaeologists, ranging all the way from prehistorians to specialists in Graeco-Roman and Islamic architecture. Moreover, the author understands exactly what excavators are aiming at—the historical reconstruction of ancient civilization. For this reason the book can be warmly recommended to all students of the past, who will lay it down with a much fuller understanding of the archaeologist's task than can be gained from any ordinary handbook of archaeology.

W. F. ALBRIGHT.

PREFACE

The manual is wricten primarily to serve as a reference book for architects in the field. It is also intended to act as a guide for other archaeologists, particularly in regard to architecture.

Chapter VI, on organizing a survey for publication, as well as the section on the theory of free restoration in Chapter VII, must necessarily be included, since much of the pertinent material must be obtained in the field.

I have felt the need of such a manual ever since leaving actual field work in 1937. Dr. W. F. Albright of Johns Hopkins furnished the encouragement that made the writing possible and I am very grateful to him for the suggestions he made from time to time that determined the scope of the project.

The completed manuscript was read by Dr. Albright and by Drs. Myron B. Smith and Pinhas Delougaz of the Oriental Institute, to whom I am indebted for many suggestions in regard to the presentation of the material. Mr. Robert Lang also read most of the manuscript for style.

I do not pretend to have developed the methods and techniques described herein. They were evolved during long and short periods of association with such people as the late Dr. C. S. Fisher, Mr. A. G. Buchanan, Miss K. Kenyon and a host of others. It is rather difficult for me to separate these various influences in my mind. Dr. Fisher had a keen analytical sense, developed by many years of field experience. He was trained as an architect and had a fine instinct for re-creating the conditions responsible for the destruction of the building being studied. His field notes were therefore always unusually complete. His chief interest lay in recording excavated material and not in scholarly restoration.

Miss Kenyon represents a school of archaeologists trained in England, where architectural remains are very rare and where a technique had to be developed for recovering and recording traces of walls which had been removed after being laid. Under such circumstances trenching becomes a necessity and some of the methods used will be described in the chapter on small excavations.

It is a pleasure to thank the American Council of Learned Societies for a generous subvention which made it possible for the American Schools of Oriental Research to include this manual among their publications. The McGraw Hill Publishing Company has, with characteristic liberality, permitted reproduction of Tables II and III (pages 7-72) from their standard text, Heineman's *Plane Trigonometry*.

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Appendix I Logarithms of Numbers and Trigonometric Functions
Courtesy McGraw Hill Publishing Company
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Courtesy Drs. C. B. Welles, N. Toll and the Gallery of Fine Arts, Yale University

CHAPTER I

REVIEW OF METHODS USED

101. In the past field expeditions have used all sorts of methods to record the architectural material exposed. All architectural records are based on some sort of surveying but unfortunately, most of the architects or other staff members have been untrained in surveying methods. Each expedition has had its own system of surveying, which, strange as it may seem, was almost always harder to manage and much less satisfactory than one based on the usual practices followed by professional engineers.

102. One expedition followed the very cumbersome method of establishing horizontal planes at very close intervals. This made innumerable field survey sheets necessary for each site surveyed, since each level had to be put on a separate sheet. The accuracy was more imagined than real since the top of any wall would be shown only by the nearest sheet. The lateral position of the walls was located by the plane table method so that the actual survey was quite accurate, though the multiplicity of levels would hinder rather than help the work of restoration.

103. This extremely cumbersome method of notation is in the sharpest contrast to the idealized system established by the Reisner and Fisher school. Dr. Fisher's goal in every excavation was to recreate as perfectly as possible the conditions that existed at the time of the destruction of the city or building period. Common sense would tell anyone with ordinary powers of observation that built-up areas are almost never absolutely level. It is also true that earthquake, fire, and wanton destruction never raze a site or building at an absolute level. Hence the simplest, cheapest and most efficient method would be to excavate a complete building level, survey it and determine the critical levels. In such cases field surveys would represent only the building levels and would be only a fraction in number as compared with the above system.

104. Another expedition insisted on keeping all the records of the survey in the form of angles in relation to one or more base lines. A plane table and alidade were never used and the position of a point of a wall was an intersection of lines drawn from opposite

ends of the base line. Here again we have a case of imagined accuracy since lines making very acute or very obtuse angles with the base line do not have a very distinct point of intersection. The director was under the impression that keeping the record of all the field work in a note book had some advantage.

105. Of course the no-method-at-all system is being gradually eliminated by the antiquity laws of various countries. Expeditions still exist where all wall intersections are assumed to be right angles. One expedition added an additional refinement to this system by establishing the orientation and relationship of the various buildings in the site with the aid of air photographs. This latter technique can be made to serve the purpose providing a skilled pilot with an excellent camera is available. In addition a photographer who has had experience in manipulating aerial photographs is necessary to adjust them to a proper scale. Obviously a good theodolite or transit would be much less expensive, except for a huge terrain, where aerial survey saves lots of time. But for actual excavations and ruins, measurements must supplement aerial surveys.

106. Unfortunately there are people who think they can draw the plan of a building or site by merely pacing off the dimensions and, what is even worse, some seem to think they can estimate the relative levels of the various elements. Fortunately, most countries make such procedure, or lack of it, illegal.

107. It may be well to point out the disadvantages of an inaccurate survey. First of all, in order to understand the effect that one building period has upon another in the same tell, it must be possible to draw an accurate section through more than one building level. This can be done only if the surveys of the various levels are tied to a common reference line. Another great disadvantage to be found in a non-systematic survey is the danger that the details of the same building or complex of buildings, if excavated at different times, will not connect. There is the famous example of one of the larger digs in the Near East which was interrupted by a roadway; when the two surveys were assembled an error of eight feet was found. An accurate survey is just as easy to do as an inaccurate one and the few simple rules that must be followed will be outlined in the next few chapters. An attempt will also be made to delimit the degree of accuracy required. Certain techniques of the professional surveyor would obviously be a waste of time and accordingly many of the suggested procedures will be modifications of established procedures.

108. It is interesting to note that in connection with taking levels, experience has shown that it is almost impossible to estimate the relative levels of various parts of a building with any degree of

accuracy without using a surveyor's level. Some years ago the staff of the Michigan Expedition to Seleucia on the Tigris tried to determine the position of the various canals and docking facilities of the ancient city, which were covered with an evenly distributed layer of sand. It was found impossible to differentiate between the canal bottoms and the dry land, even though subsequent checks with a level showed a considerable difference in level. The writer has found that it was even impossible to determine the direction of flow in the various drains in a Roman bath without the aid of a level. Therefore it cannot be emphasized too strongly that levels must be determined with an accurate surveyor's level, the operation of which is very easy to master.

109. It is perhaps needless to mention the factor of professional responsibility of the architect or surveyor, but it should be emphasized that the recording of the architectural material must be completely objective. The world of scholarship is fully dependent upon the reliability of the published material. The responsibility is perhaps not as serious as that of the architect to the public when he is building; but nevertheless the same element, that of professional integrity, is involved, and ignorance of technique is no excuse for doing an unsatisfactory job.

110. The architect is usually responsible for the purely technical aspects of the expedition. He sometimes has to hire the workmen and, if an experienced foreman is unavailable, must himself train the workmen in the technique of exposing the building walls with a minimum of damage. One of the first local assistants the architect must hire, and this is his invariable job, is the boy who acts as rod man and general helper in surveying. The latter can make the architect's life miserable and no hesitancy should be shown in getting rid of one who does not prove satisfactory. A good one —and such may be found with patience—can speed up the work tremendously.

CHAPTER II

NORMAL SURFACE EXCAVATION

Defining the Responsibilities of the Architect

201. The architect of an archaeological expedition is faced with a problem which may be simple to state but may require a very complex solution. The primary purpose of the expedition, as far as the architect is concerned, is to restore the site being dug to its state at the end of each period of occupation. The duty of the architect of the expedition is to record all available architectural evidence of each period of occupation in such a manner that a published report can be made which will be usable by subsequent students. He is also responsible for establishing the loci of all non-architectural objects that are found.

202. The successful solution of the first part of the problem depends largely upon how the architect organizes his time. He will always have a great deal of surveying and drafting to do, so he must limit the time he spends supervising actual excavation. If, however, other members of the staff can be trained to recognize and protect architectural remains as they appear, the architect can budget his time so that only occasional visits to the actual digging area are necessary.

203. The second phase of an architect's work on an expedition requires more time, and it is the purpose of this manual to organize all available techniques of the engineer and aerial photographer in order to make the task as simple and efficient as possible.

The Theory of Surveying as It Relates to Archaeology

204. The chief purpose of the survey is to tie the various sections of the site together so that even though they are excavated at different times a definite geometric relationship can be established. This is done by means of a grid of triangles called a triangulation grid, which is set up on the actual site and the angular and linear relationships of the various apexes determined with the aid of a theodolite or transit and a steel tape. The triangles are of course delimited by their apexes. These apexes are fixed on the ground by semi-permanent markers that serve as reference points and plane table positions in the topographic survey. They are also

used in the detailed surveys for the plane table positions, though generally the grid must be subdivided into smaller units in order to record the details of the individual buildings. (Figure No. 1)

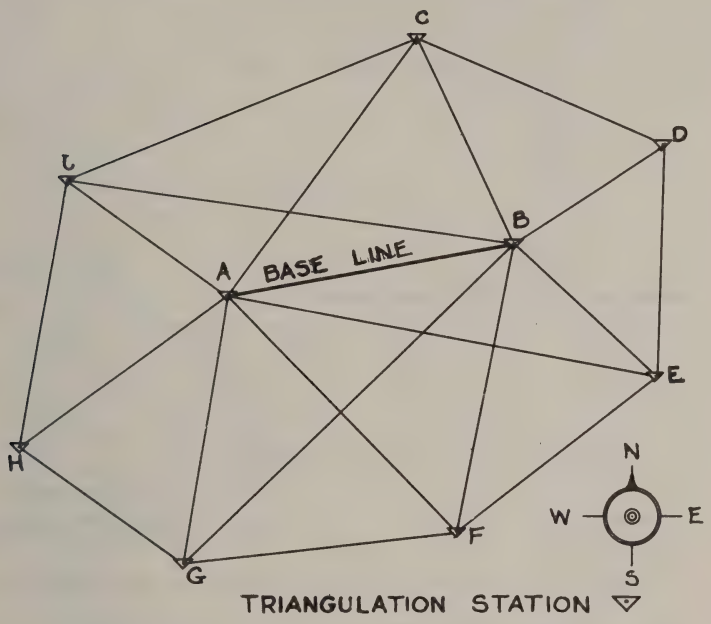


FIGURE 1. TRIANGULATION GRID OF WHOLE SITE.

205. It is usually necessary to establish smaller grids in and around the buildings under excavation before the main grid has been laid out. Their delimiting points must be preserved for later inclusion in the main survey. Several ideas for practical markers are shown in Figure No. 2. If they are made too obvious with bright colored paint, etc., they are likely to be stolen by the local inhabitants and used as decoration.

206. The triangulation grid not only serves to tie the various elements of the site together but also isolates or localizes any errors that develop on any survey.

207. General directions for laying out and surveying the large grid may best be studied in a surveyor's handbook, such as Breed and Hos-

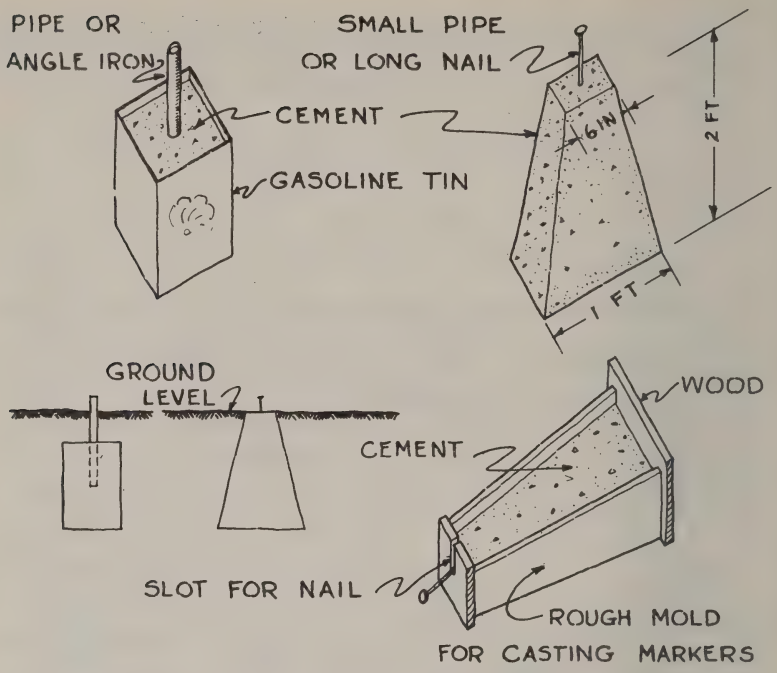
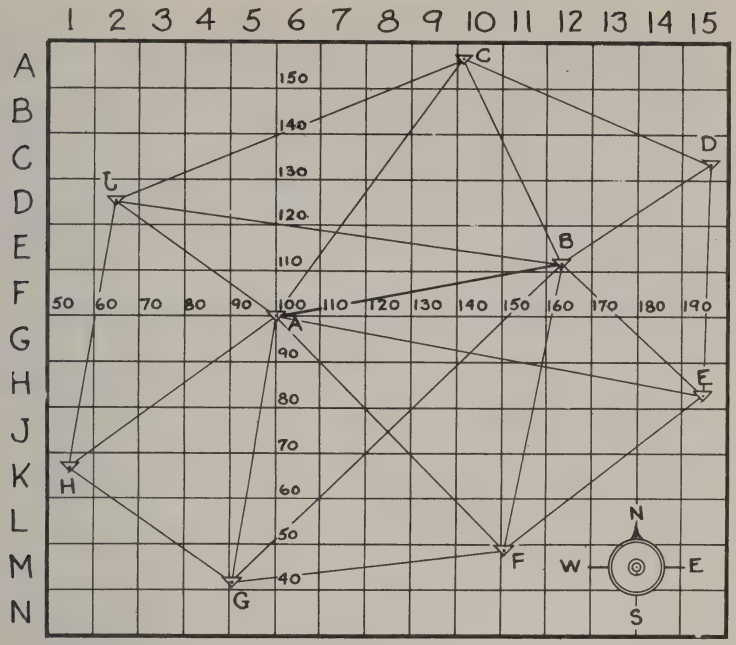


FIGURE 2 SUGGESTED SCHEMES FOR PERMANENT MARKERS.

mer, since the technique is not unlike standard practice. Corrections must be made and the errors properly distributed according to established procedure. The problem of making a topographic survey using this large grid is discussed in Chapter V.

208. The triangles used in and around the buildings are usually so small that it is possible to establish and prove a series of triangles in much shorter time than is required in the triangulation of the whole site. Directions for laying out these smaller grids will be given later in the chapter.

209. The coordinate grid can be established as soon as the triangulation grid has been surveyed and drawn up. This coordinate grid is superimposed on the triangulation grid. To establish it, some major point on the triangulation grid is chosen as the fundamental position and new lines are extended north, south, east and west. It is probably better to use the true north; or, if the magnetic north is used, it is well to make a note of the date and the compass



TRIANGULATION STATION 'A' IS THE FUNDAMENTAL POINT AND ITS COORDINATES ARE 100 NORTH, 100 EAST.
OTHER EXAMPLES:
TRIANGULATION STATION 'C' IS IN BLOCK A10 AND ITS COORDINATES ARE 157 N., 142 E.,
TRIANGULATION STATION 'F' IS IN BLOCK M11 AND ITS COORDINATES ARE 49 N., 151 E.,

FIGURE 3 COORDINATE GRID SUPERIMPOSED ON THE TRIANGULATION GRID OF WHOLE SITE.

declination at that time. With the main coordinates established it is a simple matter to draw the lines that determine relative distances north, south, east and west from the initial or fundamental position. Intervals in the grid are established as even numbers and the spaces are then usually given letters in one direction, omitting I and O, and numbers in the other. This enables any position on

the site to be defined with a simple number and a letter, a great convenience for the staff in all phases of the expedition. The apexes of the triangulation grid must be located immediately in terms of the coordinate grid so that if any of them are lost they can be easily re-determined by their relationship to other nearby points. Obviously, the importance of this grid makes it necessary that it be completed as soon as possible. It will be particularly valuable in locating finds in open areas where rooms cannot be used as references. It will be the only grid published. (Figure No. 3)

210. The archaeologist can use either of two methods of excavation which by now have become standard practice. The first and ideal method consists of clearing each occupational level completely before going on to the next level below it. The term "occupational level" describes a stratum covered with the remains of one period of history on the site. It is rarely completely level; yet some archaeologists have assumed that was the case and have badly confused matters, particularly at the edge of a site where the levels are likely to follow the natural contours of the area and fall off rapidly. (Figure No. 4)

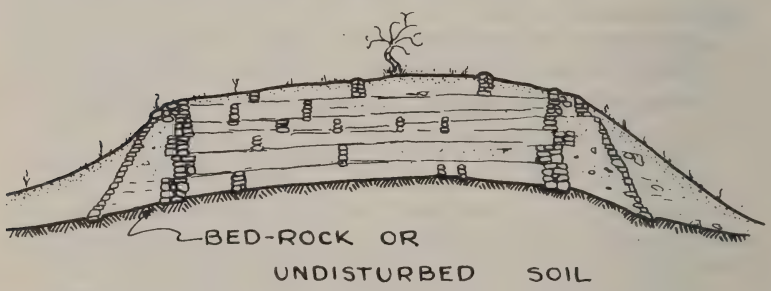


FIGURE 4. SECTION THROUGH A TYPICAL TELL

211. The reasons against using this method are largely economic. It is necessary that the whole site be either rented for a long period or bought outright. Both procedures can be expensive when the site lies in a heavily populated or cultivated area. However, this is entirely feasible in thinly populated or desert country. This system has the advantage of large working areas and the number of workmen that can be hired is limited only by the budget and the supervisory staff available.

212. The ideal procedure for the architect would be to postpone his survey until the complete level has been cleared and then install a grid, both triangular and coordinate, and do it in one operation without interference from the workmen. But this is rarely possible and it may not be feasible for a number of different reasons. It would mean, for instance, that the actual digging would have to cease while surveying was in progress, which may not be possible because of local labor market. Moreover, it is a great advantage to have accurate plans of buildings being dug as soon as possible, so that rooms can be numbered and the location of finds be more accurately marked. Therefore, the most practical method is to follow as closely behind the excavating as possible. A detailed explanation of the methods to be used by the surveyor will be found later in the chapter.

213. The less ideal method of excavating is to rent sections of the site piecemeal and excavate them layer by layer to bed rock or undisturbed soil, then fill them in before going on to the next section. This is often necessary in heavily populated areas and makes extreme care necessary on the part of the surveyor. The methods used will be described in the next chapter.

214. The architect must assume a great share of the responsibility for supervision during the actual digging, as mentioned above. The chief problem is to recognize the walls of buildings as they are exposed. They are usually covered with a layer of debris. The presence of material from the upper and destroyed portion of the wall in irregular heaps along both faces of a wall generally adds to the confusion. When the digging is first started an idea of the position and extent of the walls can be obtained by removing the top soil and exposing the comparatively undisturbed soil underneath so that difference in the texture and appearance of the uncovered material can be seen. The effect is similar to that obtained in the preliminary trenching described in Paragraph 310. Here the section exposed is horizontal instead of vertical.

215. It is comparatively simple to delimit the position of a wall when it is made up of stone laid in regular courses. Walls with irregular coursing (i.e., stones of odd sizes and shapes laid in uneven rows) are sometimes difficult to distinguish from the fallen debris. Because mud brick tends to distintegrate if placed directly upon the ground, a combination of mud, brick and stone is often used in damp areas, with several courses of stone serving to insulate the mud brick from the ground. The problem of identification is similar to that of a mud-brick wall, which is discussed below. (Figure No. 5)

216. The principal difficulty faced by an archaeologist in dealing with mud brick walls lies in the fact that the material used in their

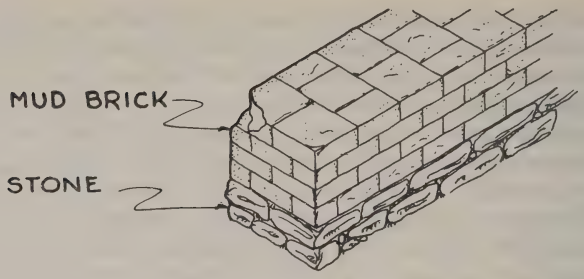


FIGURE 5. MUD BRICK WALL ON A STONE BASE.

construction is not unlike that of the earth in which they have been buried for centuries. As a result there have been a number of cases where long narrow rooms turned out to be heavy walls; in other words, the excavators recognized a slight change in color or consistency of the ground during the digging but removed the walls and left the rooms unexcavated!

217. A short description of the methods used in making mud bricks might explain why the above mistakes are not unlikely unless great care is taken. As the term implies, the bricks are made of mud and are not baked. They are sometimes called unbaked bricks. The material is generally prepared from local soil and mixed with a generous amount of broken straw. The presence of this straw is sometimes the only differentiating feature in the section of ground that is being excavated. The actual straw can rarely be found since it usually rots, leaving empty spaces where the short pieces of straw once acted as binders. Quite often these minute traces of straw are the only clue to the presence of a wall and great care must be exercised or the workmen will dig right through it. When once the trace of mud brick has been found it is usually possible to determine the size of the bricks used and the dimensions of the wall. The bricks vary greatly in size, but in any event they are never of the proportions of a modern brick. They are usually square in plan, measuring anywhere from 20 to 50 cm. on a side, and from 5 to 10 cm. thick. The dimensions will vary through the various building periods and—what is even more confusing—will vary in different sites in the same period. This variation in dimension is probably due to the fact that bricks were made on the building site with simple forms that could be assembled quickly.

218. These mud-brick walls were often plastered inside and out in order to obtain a smooth appearance. Various plastering materials were used, including a lime plaster for the inside surface. The more common finish was a mud plaster made up of material similar to that used in making the brick, i.e. mud and broken straw.

219. The presence of a coating on the wall makes its tracing easier. Once evidence of mud-brick has been found, the width of the wall must be determined. This can be difficult, because the remains of the wall are often surrounded on both sides by the debris of the upper part of the wall. It will be necessary to determine the size of the mud bricks used in order to estimate the width of the wall. These walls are usually multiples of brick width, so that no pieces need be less than a half brick. The fact that the bricks in the wall are invariably horizontal will help to differentiate the wall proper from the debris fallen from above. (Figure No. 6)

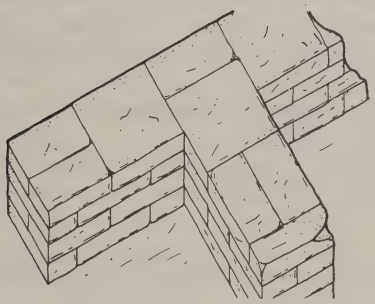


FIGURE 6. MUD BRICK WALLS BONDED TOGETHER AT CORNER.

220. When once the width of the wall is determined it is a comparatively simple matter to dig in both directions along the inside and outside faces of the wall. The corners will present some difficulties but if careful attention is paid to the bricks that make up the wall, it will be found that any intruding walls or corners will be clearly indicated by the special arrangements made in bonding. The intruding wall or corner will usually bond halfway into the wall. This, of course, strengthens this area of the wall and quite often this is the highest part of the ruins. A good plaster of lime or even of mud will be of great assistance in tracing the wall and finding the corners since the latter always receive an excessive

amount of material which remains even though the intruding wall may be missing.

221. Walls made of baked bricks do not present any difficulties to the excavator. Baked bricks are more regular in size since the places of manufacture are limited by the need for clay and fairly elaborate kilns. Baked bricks have been found in most building periods and have usually the same general shape as unbaked bricks except that, since they are much stronger, they can be and often are thinner. The bricks were not always perfectly baked and some of the walls will be found to be partly rotted near the base, especially if the soil is alkaline. This condition necessitates emergency repairs to preserve the walls while the digging continues.

222. Recognition of floors presents one of the major problems for the field archaeologist. It is important that they be located before there is much digging since floors determine the chronological distribution of the small finds. The easiest way to locate floors is by digging down the face of a newly discovered wall. If the wall is plastered a small lip will appear where the plaster joined the floor. (Figure No. 7) Most early floors were of beaten earth and

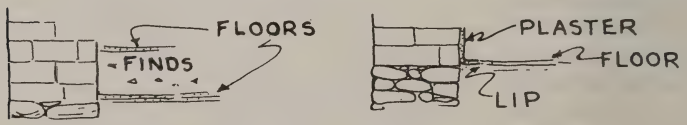


FIGURE 7. FLOOR & WALL SECTIONS.

were most solid in the center of the room where the traffic was heaviest; therefore it is very easy to miss a floor by cutting through it near a wall. A definite change in color can be noticed when the floor is reached, since a floor was deliberately laid while the debris found on it has fallen or blown in during later periods. It is, of course, easier to locate a floor belonging to a period brought to an end by a fire; here a layer of fine ashes will be found directly over the floor.

223. Beaten earth floors were (and are) usually relaid every year by packing a layer of fresh, dampened earth over the old dirty floor. This operation appears as a number of thin layers and is sometimes a help in determining the position of a floor. There is an exception to this rule which is graphically illustrated in the Odyssey of Homer, Bk. XXII, l 455, when "Telemachus, and the neatherd, and the swineherd, scraped with spades the floor of the well-builded house, and, behold, the maidens carried all forth and laid it without the doors." Here instead of raising the level of the

floor to improve its appearance, the debris was scraped off and the level of the floor lowered thereby.

224. Other types of floors are found, most of them easier to identify than the commonly-used floor of beaten earth. Stone floors, either of cobblestones, large pebbles, or flat slabs, were often used, laid directly upon the earth, with lime mortar rarely used for bedding. A third widely-used form was made with a gypsum or lime plaster which did not wear too well and needed to be renewed fairly often.

225. The type of floor will give some indication of the use of the room and offers a very definite clue as to whether or not the space was roofed. This latter determination will be useful in making the restoration. It can be assumed, in view of the erosive effect of rainfall, that any floors of easily eroded material, such as beaten earth or gypsum plaster, were protected from the weather by a roof. On the other hand, floor surfaces made of heavy stones or large pebbles laid in lime plaster that would not erode easily were probably courtyards exposed to the weather. There will, of course, be exceptions to this rule, particularly in quarters inhabited by the very poor, and the final determination must be made by inspection when the floors are newly exposed. It will be found that courtyards, even though of earth, generally had some means of protection from erosion, such as flat slabs of stone obviously placed where rain spouts would have dripped. The actual erosion of the exposed floor will give some indication, though it is possible that some erosion might have occurred in a room after the building was wrecked. The speedy erosion of excavated floors during a rainstorm will provide a graphic demonstration of what has just been said.

226. Doorways are sometimes hard to locate, particularly in mud brick walls. Ancient doors were generally not hung from hinges but swung on door posts. This made a structurally strong jamb unnecessary and the reveals were usually of the same material as the wall itself. The door-posts were integral parts of the door leaves. They usually consisted of a member longer than the leaf itself, projecting below and above the door. The lower end rested in a cup-shaped or doughnut-shaped socket that allowed the door to pivot and swing freely. This door-post socket received the full weight of the door when it was being opened so that it had to be solidly anchored. As a result these door sockets are often found even when the wall above is badly battered and are sometimes the only definite indication of the presence of a doorway. Careful investigation will almost invariably disclose several stones which were worn smooth while being used as thresholds. (Figure No. 8)

227. In more elaborate private houses and in most public buildings the doorways will sometimes be marked by elaborate door jambs and

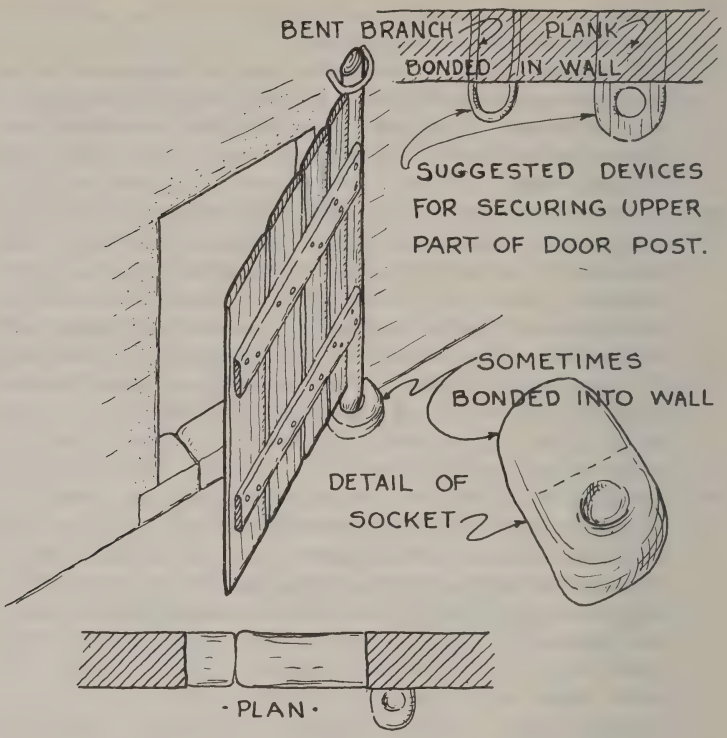


FIGURE 8. TYPICAL ANCIENT DOOR WITH SOCKET.

sills which, however, are simply decorative, the door sockets for the one or two-leaf doors being directly behind the jambs.

228. It is important that foundations be exposed at several places so that their size and relationship to the wall proper can be noted on the survey. When the level in question has been surveyed and is being removed it is well to include a number of carefully measured drawings of typical wall sections, including the foundations.

229. The architect is also responsible for the recording of all architectural fragments that appear in the debris during excavation. The architect seldom has time to stand around watching for them and it is necessary that the foreman and workmen be trained to inform him as soon as a fragment is first noticed and before it is disturbed. Careful notation should be made in the notebook reserved for the building under excavation. While the fragment is

being completely uncovered its position in the room should be measured and noted by means of a sketch. The angle it makes with the floor and any neighboring wall should be observed, particularly its relationship with the wall from which it fell. Note the condition of the surrounding debris and finally photograph the fragment after it has been completely cleared and before it has been moved.

230. It is important that the architect reach and record some conclusion as to the former usage or position of the fallen fragment before it is moved. Its position on the ground and its relationship to the wall are determining factors in restoring the architectural element to its former position. Observe carefully the condition of the underside when the fragment is moved. The type of debris, if any, found beneath the fragment is important information bearing on the destruction of the building and should be noted.

231. A large proportion of the debris will of course come from the roofs, which may have been either flat or vaulted. Little can be identified in the former type since the timber supports will invariably have rotted away. There have been instances, however, in Roman sites where flat or segmental ceilings have been hung from rafters in much the same manner as a modern ceiling. The fragments from this type of ceiling will have very definite traces of the bound reeds that once held them together. (Figure No. 9)

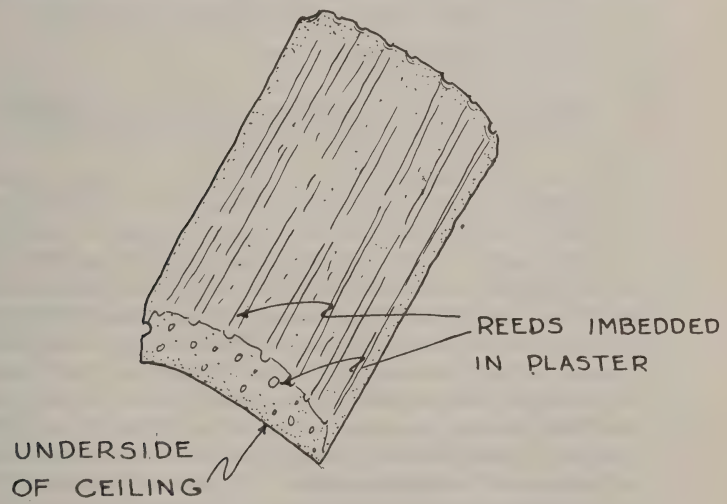


FIGURE 9. SEGMENT OF HUNG CEILING.

The vaulted type should be more easily identified since it should be possible to identify the voussoirs which form the vault. Difficulty frequently arises in the fact that the difference in dimension between the inside and outside of the vault was often made up by adding mortar rather than by cutting the stone in a wedge shape. Very close examination of the mortar found on the stones will help identify the remains of a vault. If a vault is once identified some effort should be made to determine the direction of the vault or the existence of a dome covering the room.

232. An accurate survey is needed very early in the digging, as mentioned above; hence it behooves the architect to furnish the staff with a survey as early as possible. This will mean working closely behind the actual excavating.

233. The first survey figure is usually a straight line. (Figure No. 10)

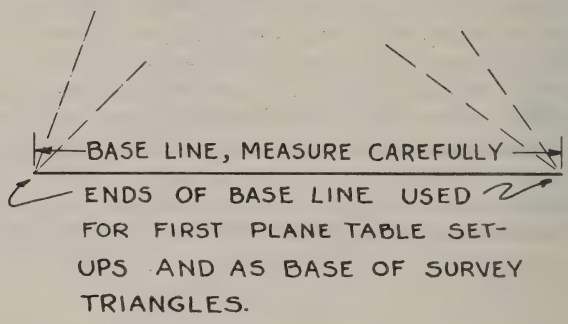


FIGURE 10. TRIANGULATION BASE.

This line acts as the base line for a series of triangles extended in the direction of the excavating. Since this line forms the basis for the trigonometric functions of these triangles, it must be measured very accurately. It should be long enough so that the triangles that are extended from it are of convenient size and the angles are not too obtuse or acute. A good length is 40 to 50 meters. If the exposed walls are low enough, it is sometimes possible to put this first line in the excavation itself; otherwise the line should be placed on unexcavated ground. In any event it should be possible to measure it with a steel tape in one operation. The points that mark the extremities of the line will be used as station points for the plane table. It should be possible to survey the included area of the dig within a radius of 25 meters from each point. A longer radius tends to be inaccurate, owing to the flexibility of the metallic tapes that are used. As more coverage is needed with the extension of digging, additional points are es-

tablished by erecting triangles on the base line. The apexes thus formed are the plane table points. Whatever figure is used must be carefully measured so that it can be reproduced in scale on the survey sheet. The first figure as stated above may be merely a line which is measured very carefully by a steel tape. This figure is drawn on the sheet to the scale used (usually 1-100) in red ink. When the survey figure becomes complicated by triangles with the above line as a base, the triangles must also be measured. This is done by measuring the angles with a theodolite or transit and proving the triangle by employing trigonometric functions. It is important that careful notes be kept on these operations, including the trigonometry used to prove the triangles. All the angles of the triangle are measured and any error distributed. The amount of error in triangles of this size is likely to be small and need not be treated with any of the care advocated in the text books for large-scale triangulation. When all of the sides and angles have been determined either by measurement or by trigonometry, the figure can be transferred to the survey sheet. The actual field survey with the plane table follows.

234. The scale used for most surveying is 1 to 100: that is, 1 cm. on the sheet is equal to 1 meter on the ground. The metric scale is invariably used in the Near East, particularly in recent years when full reports are required by local authorities. American architects will find the metric system very simple to understand and use.

235. A compass bearing should be made from one of the ends of the base line. This should be noted, with the date, in the notebook. A line representing this bearing should be drawn on the survey sheet, and the direction noted thereon.

The Mechanics of Surveying with a Plane Table

236. First set up the table and level it over a survey point so that the survey figure on the sheet is oriented approximately in the same way as the figure staked out on the ground. The position of the point on the sheet to be used must be set exactly over the stake by using the plumbing arm and plumb bob. When the point is finally set, a pin is set into it which acts as a pivot for the alidade. Using the pin as a pivot, line up the straight-edge of the alidade with another point on the survey figure. Again using the pin as a pivot and without disturbing the relationship of the straight-edge of the alidade with the second survey point, carefully shift the survey sheet until the second stake can be sighted through the telescope. The sheet should then be clamped or thumbtacked in place. (Figure No. 11)

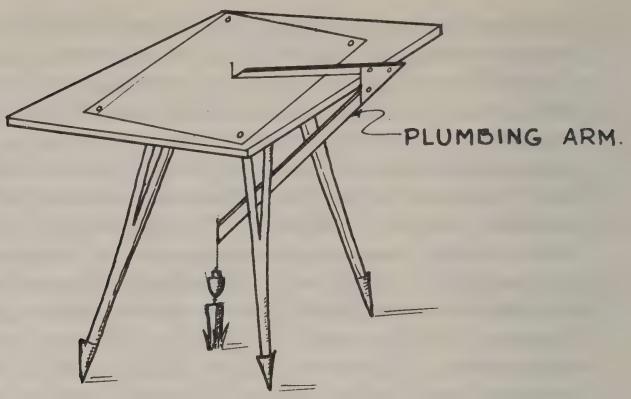


FIGURE 11. PLANE TABLE WITH PLUMBING ARM IN PLACE.

237. Before the actual surveying is started, it is necessary to mark in a semi-permanent fashion all points in and around the building that are to be transferred to the survey sheet. This is done by means of small dabs of paint. Ordinary paint of any color can be obtained almost anywhere. It can even be used on mud brick if it is applied thickly, just as it comes from the can. These marked points are the only ones transferred to the survey sheet by the plane table survey. They should include enough points on the building so that the survey can be completed by measuring from them with a 2-meter tape. The following are the critical points that should be marked and picked up in the plane table survey:

1. Corners of rooms
2. Door jambs (one side for small doors, both for wide doors)
3. Two corners for square piers
4. Two opposite points on a column
5. Several points on any extraordinary object in a room, such as drain, basin, pedestals, steps.

238. Now that the plane table has been set up and properly oriented, the next task is to transfer the details of the building or buildings to the survey sheet. Each point is located by the direction and distance from the survey point.

239. The direction is determined by sighting through the alidade telescope, using the pin through the point as a pivot, on the various critical points in the building that have been marked by the dabs of paint. A plumb bob suspended above the point by the survey-

ing assistant is one way of locating it, since the telescope is strong enough to find the string at such a short distance. Another method is to have the assistant hold a surveyor's rod on the point. Some care must be taken to keep the surveyor's rod vertical, but the vertical hair in the telescope and attention to the relative focus of the top and bottom of the rod will check that feature. When the direction has been determined by sighting through the telescope, draw a line from the pin toward the point sighted along the straight edge of the alidade, using a sharp hard pencil.

240. The next step is to measure the distance to the point on the building from the stake. This is done with a metallic tape. If the stake under the plane table is high enough so that when the tape is fastened to it and is held horizontally it clears the building, the readings may be made by the surveyor's assistant at the point above the mark. In this case the metal loop should be hooked over a nail driven into the top of the stake. In case the stake is too low, the zero end is usually held by the assistant and the readings taken at the table end. This means another assistant to hold the tape around the table. Care must be taken to keep the tape level. A nice compromise must be made in holding the tape, since if it is pulled too tightly it will stretch, or if it is held too loosely the sag will add too much to the measure. When the distance of the point has been obtained it is noted, in exact scale, on the line drawn along the alidade straight-edge.

241. After the critical points have all been transferred to the sheet, the other details can easily be drawn in with reference to the above points. A very efficient method is to train the assistant or assistants to read the tape so that they can make the smaller measurements. This will enable the architect to stay at the plane table and sketch in the details as fast as the dimensions are called to him by his assistants. Of course this makes it necessary that a common language be used but it will be comparatively simple for the architect to learn the local equivalents of the numerals as well as for the assistants to learn to read the tapes.

242. In order to identify later the points that are located, the surveyor must sketch lightly some of the detail around them. The sketches will be amplified or supplanted as the drawing is finished. As the details are being drawn, it is well to note the various types of floors. (Figure No. 12)

243. Leveling is the final task. This is most conveniently done with an instrument designed only for the purpose. The theodolite or transit works almost as well though it is somewhat harder to set up. The telescope on the alidade can be used but this is not advisable, owing to the difficulty of keeping it level. Leveling can be postponed until after the survey of a large area which may in-

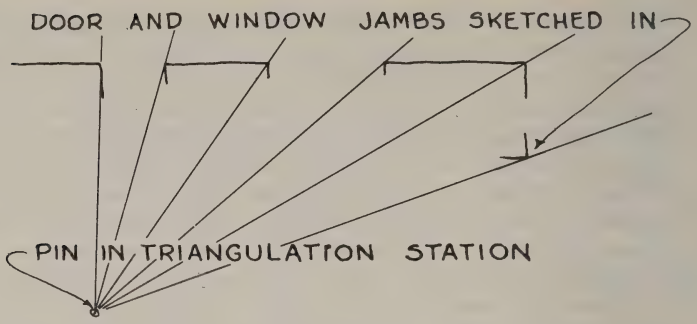


FIGURE 12. PORTION OF PLANE TABLE SURVEY SHEET SHOWING INDICATION.

clude a number of plane table positions, but no leveling should be attempted until an accurate survey has been made.

244. If the instrument is set up in a location from which as large an area as possible can be surveyed, it is often possible to conclude the leveling without moving the instrument, thereby reducing the opportunity for error. The levels in and around a building are all made in relation to one point. This point, called a bench mark, may be a fixed object such as a threshold in the building itself; or it may be possible to refer back directly to some prominent position to which all the leveling on the site can be related. Whatever is used as a bench mark, it is essential that it be tied to something permanent in or near the site. Sometimes a large rock in the expedition house court is used and so marked. Large masses of concrete have been used in areas where little stone is to be found.

245. After the instrument has been carefully leveled, the first sight is made to the bench mark; that sight, called the back-sight, is then recorded. The levels made of the various parts of the building are called the fore-sights. The difference between the various fore-sights and the back-sight is the absolute level in relation to the bench marks. As each fore-sight is made, a number is marked at that position on the survey and the same number is entered in the notebook. On the same line with the number is placed the reading of the fore-sight, the absolute level in relationship to the bench mark, and—very important—a terse but complete description of the point.

(Specimen page from book in Appendix II)

246. A notebook should be assigned to each building. It should contain all the notes on the architectural fragments as well as the levels.

Good, properly-lined, field notebooks are obtainable for this purpose.

247. List of material required by the architect in the field: (If obtainable in the field, so noted);
** absolutely necessary, * not essential but good to have.

Quantities vary with size and derivation of expedition.

**Theodolite or Engineering Transit. For measuring angles, horizontal as well as vertical. The expedition should buy the best instrument it can afford. The accuracy of the survey and the speed with which the surveying can be done will vary directly with the efficiency of the instrument. The more expensive instruments have greater magnifying power in the telescope, larger dials for reading the angles, verniers that allow for closer readings and a larger compass which also allows the directions to be specified more accurately. It may be possible sometimes to obtain a second-hand instrument with all the above attributes and have it reconditioned. This is better than using a smaller and cheaper instrument. The larger instruments have the added advantage, since they can be more readily leveled, of being usable for leveling also. A well-built traveling case is essential.

*Engineer's Dumpy Level. Here again a more expensive model with a higher magnifying power will be the most useful. Because of the inexperienced help available in the field the rods are used without targets and the readings must be made by the surveyor at the instrument, and therefore with a more powerful telescope fewer setups are necessary.

**Leveling rod. Metric scale at least 4 meters long. Since a target is not used, the English or box type is the most convenient.

*2 Surveyor's rods 3 M. long (can be made in field).

**Plane table 24 x 31 in. with tilting type tripod.

*Extra board for plane table 24 x 31 in.

**Plumbing arm. Not all of the so-called plane table outfits contain them. They are absolutely necessary in archaeology. Dietzgen manufactures one.

**Alidade. The problem is very much like that of the theodolite. A simple traverse table alidade can be used at a great sacrifice of speed and accuracy. Unfortunately most of the telescopic alidades also have spirit levels on the tube as well as vertical arcs, which are unnecessary in archaeology. The spirit level in the alidade blade is essential. If possible the blade should be graduated in the metric scale. A trough compass attached to

the base is also very useful. A well-built traveling case is essential.

**Drawing boards
one 36 x 48
one 24 x 31

**Pencils, 2 dozen of the following: 4H, 3H, 2H, HB.

**Erasers, 6 cu. in. of art gum, ½ doz. Ruby or soft ink-erasers.

**Erasing shields, 2.

**Thumbtacks, 1 gross.

**Sand-blocks, 2 for pointing pencils.

**Steel erasers, 2.

**Dusting brushes, 2 for cleaning boards.

**Protractor. The problem of purchasing a protractor is closely connected with the purchase of the theodolite or transit. If an expensive and highly accurate instrument has been bought, it is obviously necessary for the surveyor to be able to plot the results of the observations, and a protractor with an arm and vernier that read at least to 5 minutes should be bought. This is about as accurate as one can draw at the scales generally used for plotting. If on the other hand a cheaper theodolite has been bought, a xylonite (transparent) protractor, circular in shape, 10 inches in diameter and reading to ½°, will do very well for the plotting.

**T Squares 2.
one 36 in.
one 48 in. with swiveling head

**Metal straight edge (one edge beveled)
48″ long

**Triangles, xylonite
three, 30°-60°-90° 4″, 9″ and 18″
three, 45°-45°-90° 4″, 9″ and 18″

**Scales, metric flat white faced (K & E paragon)
Can be purchased in sets of six in a box 30 cm. long divided in .01, .02, .03, .05, .025, .0125.
In addition a white faced triangular scale 30 cm. long containing the same scale is useful.

**Roll of buff detail paper 36″ wide, 10 yds. long.

**Tracing paper, Natural white.
2 rolls 36″ wide, 20 yds. long.
one K & E Albatross, 100% rag or equivalent.
one K & E Ecco or equivalent.

**Mounted Drawing paper (for use in plane table) water resistant (K & E Griffin)
20 sheets 24″ x 31″

**Drawing set,—the best that can be bought.

**Package of dressmaker's pins.
**Selection of lettering pens and holders.
**Drawing ink.
6 bottles black waterproof
6 bottles red waterproof
*6 Cross section pads scaled in millimeters.
**Tapes.
2 steel tapes, mounted in reels, 3/8 in. wide, one 50 m. long, the other 20 m. long.
1 steel tape in case, 30 m. long.
6 metallic tapes, 30 m. long.
2 metallic tapes, 10 m. long.
Tape rules, 2 meters long, 1/2 in wide, curved section, for each member of the expedition.
**Surveyor's hand book (Breed and Hosmer) with math. tables.
**6 Engineer's Field Book ring binders, for leaves 7 1/4 x 4 5/8 in.
100 sheets of loose-leaf fillers
Level book rulings
Cross section book rulings
Field book rulings.
K & E makes an excellent type of binder and filler, the latter with a waterproofed surface.

CHAPTER III

EXCAVATION OF MORE THAN ONE LEVEL

301. The problem of lowering the survey grid is comparatively simple on a site where the whole area of each level is cleared completely. This was called the ideal method in the preceding chapter. The major problem is that of establishing a new survey grid every time the levels are lowered. Each new grid must be connected with the one directly above it so that the position of each point can be established on the coordinate grid and thus tie the various levels together.

302. It is rarely possible to use the station points more than once. It may be feasible to start from the base line of the grid of the level above; or, if not, any two points of the grid to be destroyed can be rechecked with a steel tape and used as a base line. It is sometimes possible to use parts of a grid in several levels where the points happen to fall in open spaces and need not be removed when the buildings are destroyed. As the levels drop, these points will eventually become isolated on mounds and will have to be abandoned.

303. When the buildings on any level have been completely cleared and surveyed, they must be removed under the direction of the architect. Careful note should be made of any feature that is exposed as the walls are torn apart. The condition and extent of the foundations and any deviation from the typical section made earlier should be noted. The construction of door thresholds is best examined at this time; and careful sketches should be made of the relationship of the door sockets with the walls. The weight of the door will be indicated to some extent by the firmness with which the socket is set into the foundations.

304. The floor of the next level should be located as soon as possible before too much work is done in removing the walls, so that a control is established for small finds in the next period.

305. The condition of the debris between the floors will sometimes give important information. Was dirt drifted or blown into place around the walls? The presence of charcoal in large pieces or in masses of small particles will indicate that the buildings were

destroyed by fire. It is possible to determine whether or not the site was immediately rebuilt by examining the debris immediately above the floor and next to the wall. Ancient sites, particularly when mud brick was used, were rarely cleared out after being destroyed. It was usually easier to level off the area by filling in the spaces in and around the walls and starting anew. It is sometimes possible to tell how soon a site was rebuilt after being sacked by the amount of drifted sand that can be found next to the wall beneath the debris belonging to subsequent levelling.

306. Small deep excavations of more than one level are necessary when the ideal method of clearing the whole site completely, level by level, cannot be followed. It is often highly undesirable in some localities to put too much cultivated acreage out of use for a long period.

307. The site should then be divided into units that can be efficiently worked by the available workmen and properly supervised by the archaeologists on the staff. Where each unit is completely cleared level by level to bed rock, it is necessary to have vertical as well as

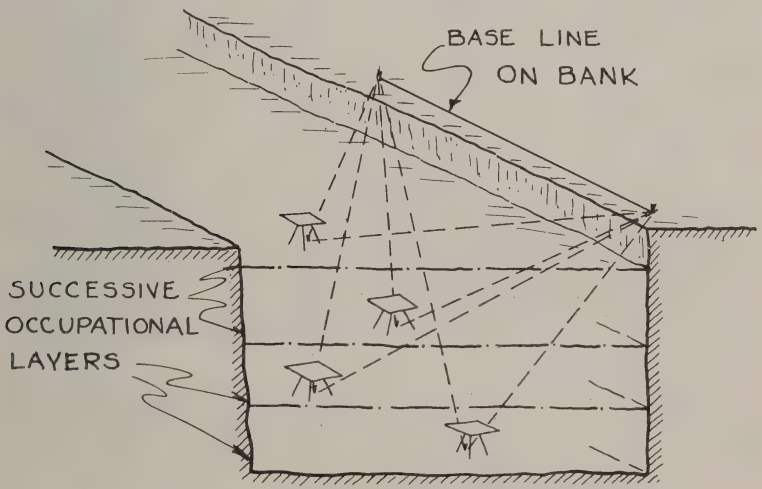


FIGURE 13. SHOWING RELOCATION OF PLANE TABLE ON SUCCESSIVE OCCUPATIONAL LAYERS FROM THE ENDS OF THE BASE LINE ON THE BANK.

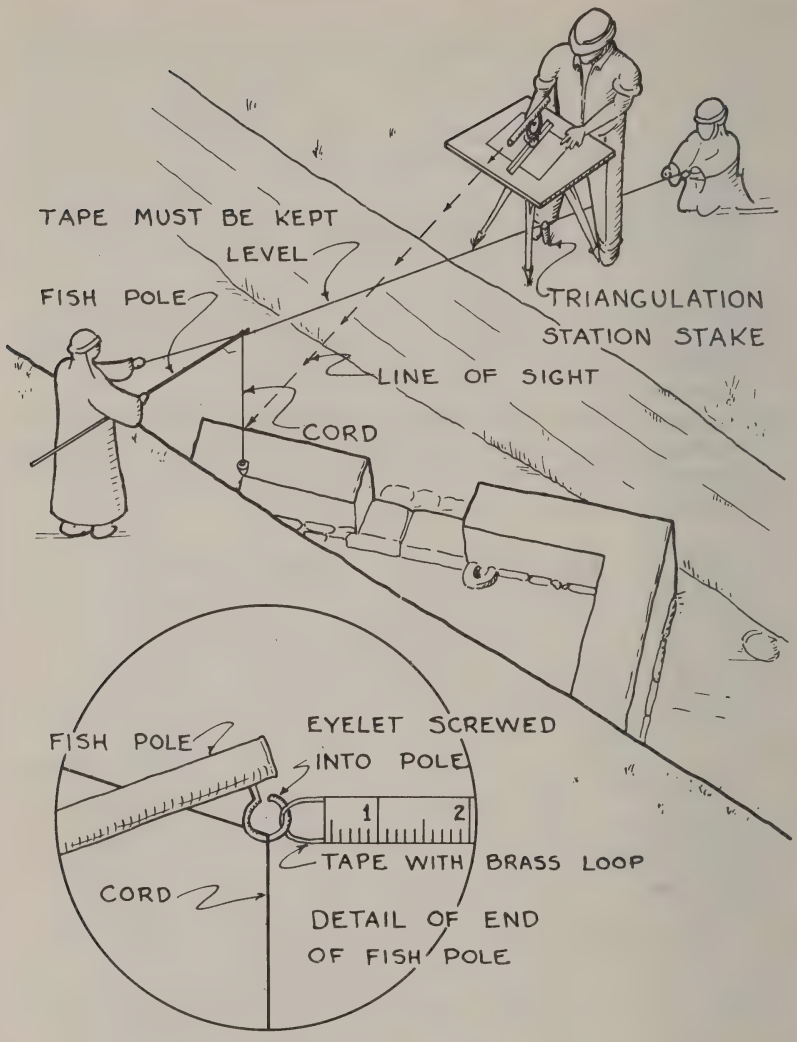


FIGURE 14. METHOD OF SURVEYING WALLS IN DEEP TRENCHES FROM THE BANK.

horizontal control of the surveying and each unit must be completely self-contained.

308. The survey figures used are a number of triangles with the same base line. This base line is maintained on the undisturbed ground next to the excavation and allows any number of triangles to be erected upon it in any direction vertically or horizontally. In other words, an apex used as a station point for the plane table can be established in any stratum at any position and its position located with reference to the base line. This is done most conveniently by setting up the transit at each end of the base line, sighting on the apex and locating the point by intersection on the survey sheet. (Figure No. 13)

309. In very small and narrow excavations it is sometimes possible to keep the plane table on the unexcavated bank. The survey figure will be a simple line defined by two points. Either point can be used as the plane table position. The actual survey can be handled by the so-called fish-pole method, whereby the point is located by a plumb bob suspended from the end of a bamboo fish-pole, which in turn is attached to the end of a tape extending from the stake beneath the plane table. (Figure No. 14)

310. This method of surveying can be used to great effect when it is necessary to run trenches. Trenching alone is not to be recommended as a system of excavating, but it must sometimes be used to find traces of walls that no longer exist but whose earlier presence is suspected. A trench cut at right angles to the estimated position of the missing wall will expose a section which will make it possible to estimate the size and former position of the wall with some accuracy. This can often be done because of the fact that the color and condition of the ground are different where the wall has been removed from that on either side in relatively undisturbed areas. Trenching is also a useful method of determining the cross section of a mound of occupational debris. In fact, it might be well in general to drive a single trench through the area

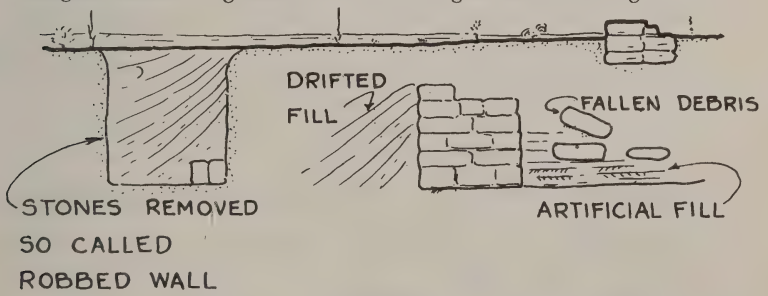


FIGURE 15. TYPICAL SECTIONS FOUND IN TRENCHING.

under excavation, so that any trace of robbed walls can be noted before all traces have been eliminated. These trenches will also tell the careful excavator who examines the sides how the debris was deposited. Artificial fill can usually be identified by the regular horizontal striation in a vertical section, while drifted fill will be deposited in angles much like that of snow against an obstruction. (Figure No. 15)

311. The problem of positive vertical and horizontal control becomes very important when working with the Nervous Digger. The latter is very impatient if spectacular finds are not made the first week. He insists upon digging in all directions and makes it almost impossible to preserve a survey figure long enough to get anything recorded. It will be necessary to add to the figure in any direction in order to preserve some control when the director decides that the greatest find of the century lies just under one end of the base line. If the survey points are abandoned one at a time and if careful notes are kept, it is usually possible to keep a record of the figure. Unfortunately, most of this is likely to happen in the first few weeks of work before it is possible to determine the coordinates of the points; but even if the figure that finally emerges is a polygon with the central parts of the figure missing, it should be enough to connect up with the main survey, made later. The chief difficulty will arise with various bits of deeper layers that are uncovered. Usually all that can be done is to tie them up with the walls of upper layers by means of sketch notes which may be added to later surveys.

312. In contrast to the Nervous Digger we have the over-cautious type. He is the Director who can never make up his mind about the original purpose of a wall or other architectural feature and insists upon leaving it standing even though the sections around it have dropped several layers. He hopes that the actual remains will eventually inspire him in making the restoration. Here a good part of the trouble can be credited to a lack of knowledge of the fundamental principles governing building at any period. This is the time when tactful suggestions from the architect plus a few quick lessons on the elements of construction will be very helpful in preventing interference with the normal development of the survey figure. The worst thing that can happen is to find one of the survey points on the isolated element. A tripod should be erected over the point holding a plumb bob directly over the stake, making it possible to take a sight on it for the establishment of a new set-up for the plane table. (Figure No. 16)

313. Smooth and orderly progress of field work depends greatly upon the speed and efficiency of the architect-surveyor in recording visible architectural finds. To hasten the removal of obstructions

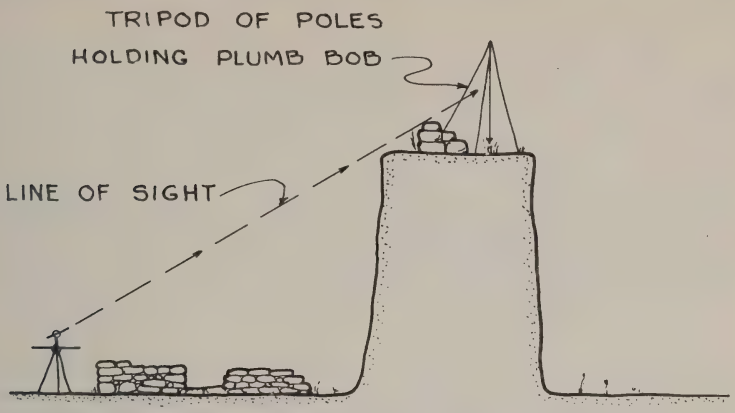


FIGURE 16. METHOD OF SIGHTING ON A TRIANGULATION STAKE OBSCURED BY WALLS OR UNUSUAL POSITION.

and halt destruction of important remains before they have been recorded, the architect may tactfully suggest that a staff meeting be held once a day in the field. When the entire staff understands the situation, it will be almost impossible for one person either to obstruct the orderly removal of recorded remains or to remove material before it has been recorded. It will be found that problems studied by such a group are rarely insoluble and that this meeting is an excellent opportunity for the architect to give some lectures on elementary problems of architectural construction with examples close at hand.

CHAPTER IV

SURVEYING A BUILDING PRESERVED TO SOME HEIGHT

401. The survey procedure for an ancient building which is not completely ruined is much like that for a small excavation. The base line of the survey figure must also be kept outside the building in most cases. The usual complex of rooms and passageways found in most buildings will preclude the erection and measurement of an inside base line that is long enough to be of any use.

402. It is usually possible to select a clear level space next to the building for a base line which can be readily and accurately measured. This base line must be preserved and tied in with the general survey.

403. The plane table positions will be the apexes of one or more triangles erected on the base line. These points are located by sighting from both ends of the base line as before; their positions are fixed on the survey sheets with the aid of a protractor which reproduces the sights taken through the transit. The intersecting lines so determined fix the point. Since intervening walls will sometimes make it difficult to sight directly on the stake as described above, it will be found convenient to erect above the stakes tripods which can support a plumb bob on a long line, thus making it possible to orient the plane table or even the transit itself without actually seeing the stake.

404. The stakes marking the apexes should be so located that practically every corner of a room can be reached by the tape. In a small building one position will suffice while a larger building will require many more. These points can be tied together and the figures proved trigonometrically or they can be tied to the base line only.

405. In very regular plans it is not always necessary to have every corner located, particularly if the walls are of uniform widths. Here again before actual surveying with the plane table starts, it is necessary to mark with paint all points that are to be recorded on the sheet. The following are critical points:

Corners of rooms
Door jambs
Any peculiar wall construction
Indications of spring of arches
Position of windows
Stairs

406. After the survey is complete, very elaborate sketch notes should be made of wall sections. These should be drawn to the same scale as the plan (1-100) before the expedition closes, since one invariably forgets important dimensions that can be supplied only on the site.

407. It is most important to keep a careful record of fallen architectural fragments. Often they have to be removed in order to lay tracks and make pathways for the removal of debris. The lower parts of some walls will be found to be rotten and will need repair. In other cases it will be necessary to remove walls either because they are dangerous or in order to make openings for the removal of debris. In any event careful notes must be kept on the height of the wall and any unusual feature in it.

408. It is sometimes necessary to survey a building that has been preserved to such a height that it is impractical to use the usual triangular survey figures. In that case the error can be controlled only by using a linear figure and keeping it simple. It is suggested that as many of the angles as possible be kept at 90°. Since it is rarely practical to close such a figure, the measurements that establish any plane table set-ups should be carefully made with a steel tape along lines that are established with the aid of the theodolite. In some cases it is possible to mark the termination of right angle lines on the walls and so develop the figure in cross section paper without using a plane table. (Figure No. 17)

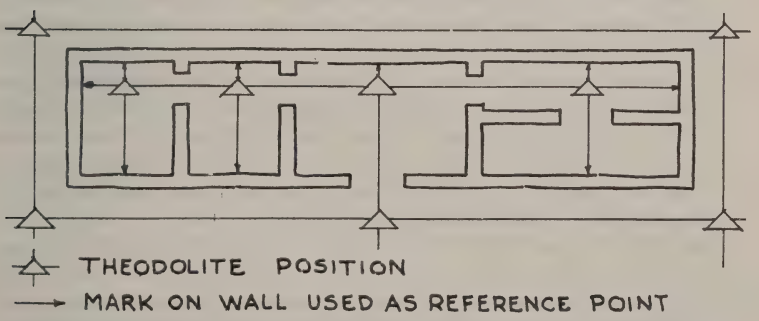


FIGURE 17. SURVEYING A STANDING BUILDING

CHAPTER V

TOPOGRAPHIC SURVEYING

501. A contour survey of the site is usually necessary for publication. Great accuracy in the delineation of land forms is not necessary in archaeology since no estimate need be made regarding the time needed to complete an excavation based on the volume of earth to be moved. It will be possible to sketch the contours with fewer station points than are used in general surveying.

502. The task of making a contour survey must usually go on while the actual excavation is being carried on in one corner of the site.

503. The first problem is that of making the large triangulation grid, described in Chapter II, paragraph 204. As has been said in paragraph 206 in the same chapter, little variation from standard practice is possible. The technique of using the instruments and drawing the grid had best be studied in a standard textbook and the usual system of distributing the errors followed. The large size of the triangles will bring up the problems that the professional surveyor meets every day. The station points must serve two purposes in an archaeological expedition. In the first place the contours are sketched from them and in the second place the more detailed grids, described in Chapters II, III and IV, must include these station points of the main grid. This will serve to tie the various parts of the site together. So it is well to keep in mind this dual purpose of the stations on the main grid when their sites are chosen. The smaller grid where the actual digging is taking place is, of course, included immediately. The stations in the unexcavated portion must be well marked so that they are not easily disturbed. The information obtained as a matter of course, i.e. the coordinate position and the level in relation to the main bench mark of the site, will be very useful when the digging expands.

504. The actual contours are drawn in with the aid of a plane table and alidade but, as said above, more actual sketching is possible. A good textbook will give a detailed account of methods used.

505. Aerial photography has been developed to such a point that some of the techniques used by our air-force are applicable to archaeology. None of the techniques available, however, would justify the purchase of a plane with all the attendant upkeep. In the past it has usually been possible to persuade the military air-forces of the various countries to make aerial surveys for practice. With the increased use of commercial planes in the future, it should be possible to have the photographic work described in the rest of the chapter done when needed by a professional aerial photographer.
506. The use of aerial photography for reconnaissance work is well-known. One of the first spectacular demonstrations was the discovery in 1919 by Mr. O. G. S. Crawford of the missing portion of Stonehenge avenue. It has been used extensively in the study of Roman England and aerial photographs have guided digging since that time. They have also been used in the study of Indian mounds in America and they will without doubt be used more extensively in the future. Our knowledge of pre-Columbian civilization in South and Central American has been increased by photographs of extensive earthworks which are only visible from the air.
507. Aerial surveys have been used very widely in the Near East in recent years. The British and French air forces have been most helpful in trying out new techniques. At Megiddo cameras attached to captive balloons have taken photographs used to supplement the actual surveys of small areas. A more significant use was made of aerial surveys at Seleucia-on-the-Tigris. That site consisted of approximately five square miles of sand dunes with very little evidence on the surface as to the position of any of the important buildings that were known to have existed in the city. It was found, however, that photographs taken from some height had very definite indications of the existence of a grid system of streets. Close study revealed that certain parts of the system were interrupted by large areas. Subsequent excavation revealed that these areas were occupied by large public buildings which with their subsidiary structures extended over more than single city blocks. This made it possible for the expedition to excavate the major public buildings first.
508. The aerial surveys of Eric Schmidt in Iran and that of Poidebard in Syria are well known for their contributions to our general knowledge of the topography and ancient routes of these areas.
509. In an article in the *Geographical Journal* (Jan.-Feb., 1945) Mr. J. K. St. Joseph discusses the effect of buried walls and roadways on the root structures of growing plants. It is suggested that before any digging is done a series of aerial photographs be made

which depict the area under various climatic conditions. The changes in the soil under different climatic conditions will bring out a more complete picture of what is to be found beneath the soil. This would undoubtedly be cheaper than the usual blind digging.

510. Aerial photography has been found useful in reducing the amount of time needed in making the contour survey of a site. The main triangulation grid can be traced on the photograph which has been enlarged to a definite scale. Natural features such as paths or road intersections can be picked out. Bushes or large rocks will sometimes serve just as well. If the photograph is made after the work has begun, it is possible to set out targets that are the equivalents of the survey points of a triangulation grid. White-washed stones or strips of white cloth can be seen at a great height. Such a grid is not as accurate as one made by regular methods and the levels must be taken on the ground in any event. This type of a grid would certainly not be accurate enough for the survey of a building complex. A mosaic of photographs if assembled with controls could be used but would be even less accurate. But as said above, the contour map of an archaeological site need not be too accurate. Aerial photographs for this purpose are, as a rule, best made in early morning sunlight, to reveal the relief to best advantage.

511. A new technique of aerial surveying has been developed in recent years, using the stereoscopic effect. The principle is exactly like the stereoscope found in every parlor a generation ago. The effect of exaggerated definition which made the parlor toy so interesting can be used to advantage in archaeology. The stereoscope photographs are made with a large overlap in both directions. It is generally recommended that the overlap be 60% in the direction the plane is flying and 50% in the other direction. This makes each portion of the topography visible from more than one viewpoint. For this type of work the aerial photographs must be made between 10 A.M. and 2 P.M.

512. A simple stereoscope has recently been made available. It consists primarily of a pair of magnifying eyepieces. Some models have in addition a pair of prisms and mirrors. This device makes it possible to view the various topographic elements from the angles established by two positions of the plane. (Figure No. 18)

513. The exaggeration of relief will be such that elements that are barely noticeable in a simple photograph stand out boldly. The effect is obtained by the fact that the two viewpoints, corresponding to the human eyes, are moved a greater distance apart by using the overlapping photographs. This lessens the natural foreshortening of the vertical surfaces. (Figure No. 19)

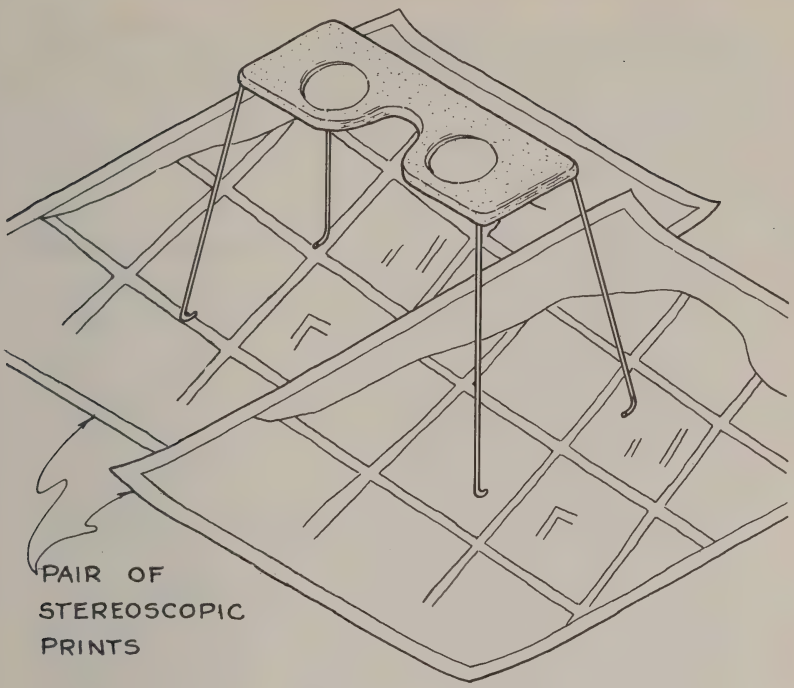


FIGURE 18. SHOWS THE USE OF A SIMPLE STEREOSCOPE WITH A SO-CALLED STEREO PAIR OF PRINTS.

514. This effect is very helpful in ordinary aerial reconnaissance work where every slight relief may be an important clue to what exists beneath the surface. It would probably be too expensive for large scale reconnaissance work but could be used for small sections that look promising after casual inspection. It would be very useful in the detailed study of a site about to be dug, such as was described above in Seleucia-on-the-Tigris.

515. These stereoscopic photographs can also be used in making the rather simple contour maps that are required in archaeological reports. It is possible to do a complete leveling job from these photos alone without any connection with the field, but the ap-

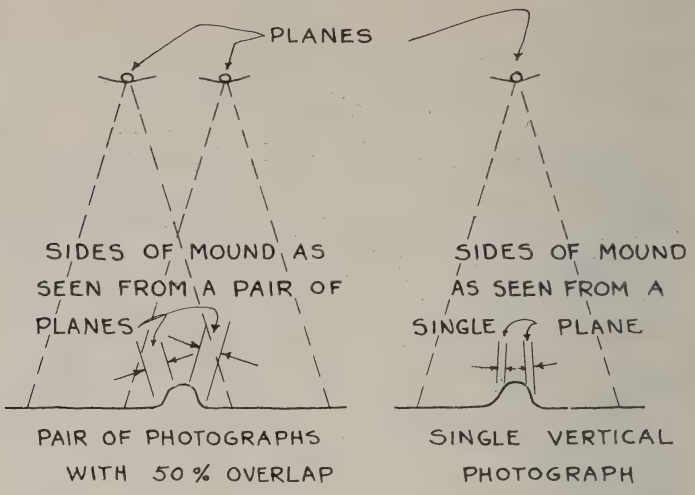

PLANES
SIDES OF MOUND AS SEEN FROM A PAIR OF PLANES
SIDES OF MOUND AS SEEN FROM A SINGLE PLANE
PAIR OF PHOTOGRAPHS WITH 50% OVERLAP
SINGLE VERTICAL PHOTOGRAPH

FIGURE 19. SHOWS HOW A PAIR OF STEREOSCOPIC PHOTOGRAPHS EXAGGERATE THE HEIGHT OF A MOUND WHEN FUSED TOGETHER.

paratus is much too complicated and expensive and the results are not too reliable.

516. A very simple and direct method combines aerial photographs with selected levels made in the field. The first step is to run several levels across the site, recording the actual level position on a sketch map and marking them in such a manner that they will show in the aerial photographs. Lines of whitewashed stones crossing at right angles will do very well. A careful record of these levels must be kept in a notebook, tied in with the above-mentioned sketch of the site by corresponding numbers. When all the required levels have been secured and marked so that they can be seen from th air, aerial photographs should be made with the proper overlap. When these are available it will be possible for the surveyor who is now familiar with the site to sketch the contours in the office in a much shorter time than would be required to do them in the field and with a high degree of accuracy. This system can also be used with photographs already made, but with less accuracy and more need of direct reference to the actual site.

517. For more detailed information, refer to

H. T. O. Smith, *Aerial Photographs and their Applications,* New York, 1943, Appleton-Century Co.

T. Abrams, *Essentials of Aerial Surveying and Photo Interpretation,* New York, 1944, McGraw-Hill Book Co.

These contain the latest information on the subject.

CHAPTER VI

ORGANIZING A SURVEY FOR PUBLICATION

601. The coordinate grid system as described in Chapter II, paragraph 208, has other uses besides those immediately apparent in the field. Owing to the absolute regularity of the grid, it can serve to control the reduction of the scale of the survey drawings for publication.

602. The coordinates should be inked in as soon as they are determined. It has been found convenient to differentiate between the two types of grid by putting the triangulation grid in red ink and the coordinate grid in black waterproof ink. The black waterproof ink will photograph perfectly while the red ink will show as a fainter gray line. This will be sufficient since the triangulation grid is useful only in the field and rarely needs to be considered at any other scale except that used in the field.

603. The most convenient scale to use in field surveying is 1:100 (1 cm. equals 1 meter). This is an adequate scale for detail as well as for the over-all plan of a building, and enables the surveyor to get a fairly large plan on a standard 24″ x 30″ plane table sheet.

604. This scale is obviously too large when a drawing of the plan of a whole site must be made. The scale that is often used is 1:1000 (one cm. equals 10 meters). At this scale it is possible to put an area 1200 meters square on a sheet, five feet of each side. Another convenient scale is 1:500. This allows for more detail and is used in smaller sites.

605. The major problem in preparing a survey for publication is that of reducing the scale of the drawings. This can be and has often been done with the aid of a pantograph, a mechanical device that will reproduce in reduced scale any drawing that is traced with one of the arms. This is a long and tedious process and is scarcely economical on a large site.

606. It is possible to obtain reasonably good results in an extremely short time with the use of photography to obtain the reduction. A plate camera, using 5 x 7 inch film with a view-finder of ground glass for focusing has been found to be most convenient. The survey sheets must have the plans and coordinate grid lines drawn

in black waterproof ink and, in order to simplify the use of the reduced prints later, two lines of the coordinate grid crossing at right angles should be present on each sheet. If that is not possible, a point on the line present should be marked showing the distance from the nearest intersection of two major coordinate grid lines.

607. The camera should be set up as solidly as possible with the axis of the lens at right angles and the camera back parallel with the surface upon which the survey sheets will be attached for photographing. Unless great care is used in aligning the negative, lens board and drawing mount in parallel planes, distortion will result. To check, draw a large square, label its sides, and photograph it; by measuring its image and making any necessary adjustment, error can be eliminated. A fully corrected (anastigmatic) lens and small aperture are indicated. The reduction can be determined roughly by actually measuring the image in the ground glass of the camera and can be established at a fixed ratio of ⅕ or 1/10. Trial negatives should be developed and checked to make certain that the scale of the reduction is correct, and adjustments made accordingly in the focus. The degree of accuracy required is so high that checking the focus on the ground glass is not accurate enough. When the test negatives prove the scale of the reduction to be correct, the test for alignment mentioned above should be made. When completed and ready to proceed, make sure that the camera and the board that holds the drawings are held solidly in place so that all the prints will be of the same scale.

608. When all the negatives have been made, proceed with the printing. This may be done by a professional but under certain conditions. First, the prints should be by contact only and secondly, they should be made on double-weight paper. The first stipulation of course prevents any change of scale by enlargement and the latter reduces the error due to the expansion and shrinkage of the paper when wet. The grain of the paper makes this change of dimension unequal in the length and width, but the thicker the paper the less noticeable it will be. Prints on single-weight paper are useless for this purpose.

609. There is, of course, nothing new in the method of obtaining reduced-scale drawings. After the large-scale survey sheets have been inked in and the coordinate grid lines drawn, they could be turned over to a printer and engraver, who would be able to make the reduction even more accurately than by the method described above, since his apparatus is designed for this operation. Unfortunately this method is too expensive unless large quantities of copies are needed, while at this stage of the reduction only a few copies are needed.

610. The reduced-scale photographs are used to assemble a mosaic map which can be traced and the tracing can then be used for final reduction to the scale of the published drawing.

611. A board must be prepared large enough to receive all the photographs that are to make up the mosaic. The largest width of tracing linen readily purchasable is sixty inches, which would limit the width of the finished drawing. Since the linen is avail-

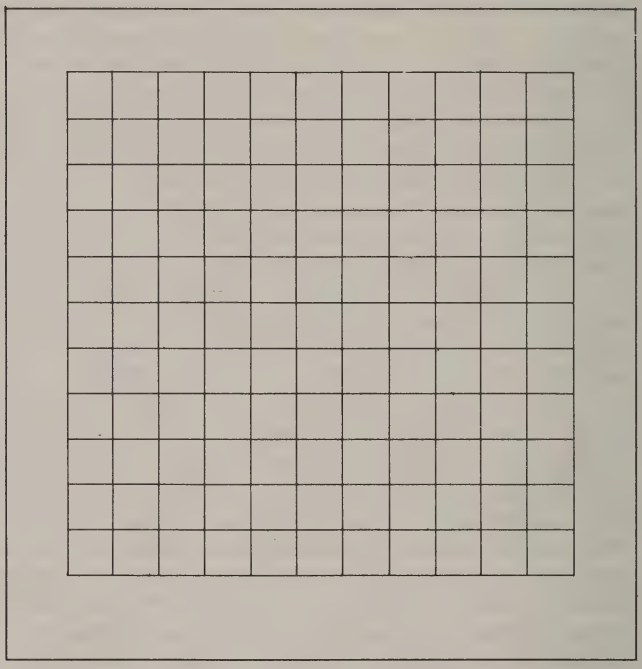


FIGURE 20. THE COORDINATE GRID DRAWN AT A SMALL SCALE. THE PHOTOGRAPHS OF THE BUILDING SURVEYS, REDUCED TO THE SAME SCALE, AND WITH A PORTION OF THE GRID PLOTTED ON THEM, ARE MOUNTED THEREON.

able in rolls, a greater length is possible. A good firm surface is necessary. Masonite building board mounted on battens and later covered with ordinary detail paper makes an excellent surface. After the board has been prepared the first step is to lay out the coordinate grid at the required scale. (Figure No. 20) Of course the scale should be that of the photograph of the survey sheets. 1/500 is about the smallest scale that will allow for any detail. The grid serves as control in assembling the prints. It also serves the purpose of preventing the accumulation of any errors which may have developed through the distortion of the lens or of the paper when wet.

612. The grid lines on the photos are superimposed on the grid lines that have been drawn on the board. The first assembly is made with the use of pins, disregarding the overlap. When the mosaic is completely assembled the overlaps are cut out with a razor blade. Care should be taken to use as much of the center of the photographs as possible to avoid any distortion caused by the lens of the camera. In other words, to achieve a good butt joint, cut equal amounts off two overlapping photographs instead of doing all the cutting on one print. After the prints have been com-

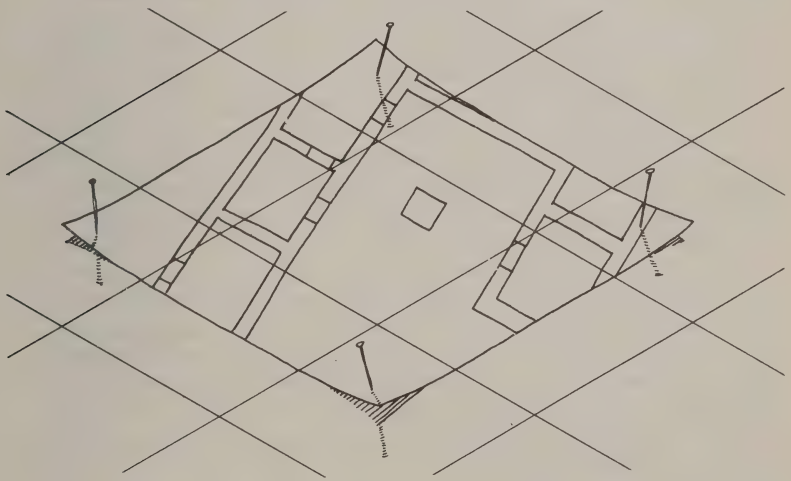


FIGURE 21. SHOWS THE PRINT OF A SECTION OF THE SURVEY SUPERIMPOSED ON THE COORDINATE GRID.

pletely trimmed and temporarily held in place with pins, the next stage is to paste them into place with rubber cement. Rubber cement will be much better than any water-soluble glue because it will not wet the paper, and, therefore, will not cause distortion. (Figure No. 21)

613. When the mosaic is complete, the contours and other supplementary detail can be added to the drawing. The final drawing is usually made by tracing the mosaic on tracing linen. As mentioned above this can be obtained in rolls up to sixty inches wide, is easy to work with, and is not affected too much by change in humidity. The latter factor becomes very important in dealing with large drawings at small scale.

614. The border and legends are added at this time. If contours are to be shown, they should be drawn at this time in another color. The final reduction, usually to one quarter of the final drawing, is made by the photo-engraver.

CHAPTER VII

PREPARING THE ARCHITECTURE OF A SITE FOR PUBLICATION

701. The architect has two tasks to solve in preparing his portion of the publication. First of all the architectural evidence that has been exposed must be presented in a completely objective manner. Plans and sections must be drawn showing the position of the uncovered walls, their height and any special features. The position of any fallen material with respect to the walls should be noted, either on the plans or in the accompanying text. It is very important that the material be presented in such a form that it be intelligible to the layman as well as to the trained archaeologist. A nice balance must be established between too elaborate drawings showing the shape of every stone uncovered and the black outlines that conceal any variations in the construction of the walls. Either technique tends to conceal the evidence.

702. The second task facing the architect is the preparation of suitable restorations of both plans and elevations of excavated buildings. In order to achieve complete objectivity it is important that these two problems be worked out independently. It will be explained later how it is possible to present their solution in a single exposition. These restorations must be based on the evidence of plans and sections. The evidence pertaining to position, size and condition of the fallen fragments will also assist in restoration. A knowledge of all parallel published material is essential, since other sites have often yielded comparable buildings with more of the original structure intact. When all the above aids fail, final recourse must be to common sense and to certain obvious principles which always hold true in architecture. A detailed analysis of these procedures will be given later.

703. Before the architect starts to turn his field notes and surveys into finished drawings that are to be published, he had better consider the final form in which they are to appear. The architect and the editors of the publication can save themselves much trouble and avoid expensive recopying of work done in the wrong

technique if some attempt is made to foresee the actual conditions that will attend the publication. Many a publication has been unnecessarily delayed or even abandoned because the architect prepared the drawings in such a manner that no one could afford to print them. The architect is fortunate if the drawings he is preparing will appear in a publication that is part of a series, some volumes of which have already appeared. In that case the format has been established and allowance can be made for the proper reduction and types of reproduction from the very beginning. If on the other hand the drawings are to appear in a volume of undetermined size, special care should be taken to prepare the illustrative material in such a manner that almost any reasonable change in scale is possible. A brief resumé of the methods used by printers to reproduce drawings will be helpful in planning the publication.

704. In manufacturing a book, two principal methods of reproducing drawings are available to the printer. The cheaper and more widely used method is the zinc etching or line cut. This method reproduces any drawing or print with solid black lines or dots on a white or neutral background such as tracing linen. In making drawings for such engravings only black India ink should be used, variation of the tone being obtained by varying differences in thickness of the line rather than by changing the color. No washes can be used, but a gradation in tone can be achieved by stippling (with black india ink) or by using Ben Day tints.

705. A third method, photo-offset "lithography," also called photo-litho, is coming into general use. In this system each page can be assembled completely and finally before being submitted to the publisher, who reproduces it exactly as given him. Any type of illustration can be used separately or together in connection with the text, including line drawings, but wash drawings and photographs do not reproduce quite as well. Since the relationship of the text to the illustration is here the responsibility of the author, the quality of the product varies with his fortune in securing a good typist and in his taste in organizing the pages. A large choice of type faces, some imitating printer's type, are available on the special typewriters for photo-litho composition. A variation of this method, but one which adds another step and therefore something to the cost, consists of submitting the pages which have been assembled by the author to a printer who sets them up in type, duplicating the arrangement of the typewritten pages. A good clean proof is taken from this type, the illustrations added, and then photographed for use in the offset presses. This last method, of course, requires careful final proof reading but results in a very professional looking publication.

706. Drawings are invariably made on sheets much larger than those used in the final publication. It is desirable that the finished reproduction be printed at a standard scale, but, since the architect does not always have complete control over the reductions made in the publishing, it is essential that a clearly drawn graphic scale be an integral part of every drawing.

707. Another important factor to be considered in relationship to the ratio of reduction is the effect such reduction will have on the quality of line in the finished drawing. In other words an estimate must be made, before the final drawings are begun, of the ratio of reduction so that the thinnest line used on the drawing will not tend to disappear or degenerate into a series of broken lines. This matter is very critical in zinc etchings where the thinness of the line is limited by the strength of the metal. All lines have a tendency to thicken slightly in the etching process. Care, too, should be taken in the matter of lettering the drawings so that the lettering is legible in the published size. Again, this is a purely mechanical matter, since very fine letters in a zinc etching tend to fill up with ink during the printing and thus become illegible. A sample of the lettering drawn at the reduced scale will be of use in determining the result.

708. In planning the sheet layouts it is best to assume that the reduction in the scale of the drawings for publication will be under the control of the architect. A reduction of at least one half is highly desirable. For decorative details, ornament, etc., a reduction to one third, linear, is best. It is much more convenient for the draftsman to work on a large scale, both for the elevations and the plans, since details can be drawn in more easily than on a small scale drawing and greater accuracy can be achieved. Reduction in the scale of a drawing always improves the appearance of the rendering. The slight uneven character of any freehand ink line tends to disappear when it is reduced. The relationship of the reduced scale drawing to the format of the publication is a matter that must be determined as early as possible. Plans should be bound in with a minimum of folding. A good scheme, which is not used as often as it should be, is to have the folded plans attached to the outer edge of blank sheets bound into the publication. This allows the plans to be opened out full and be available for reference when the detailed description is being read. After considering all the above problems a nice compromise must be made in determining the scale to be used in the final publication, to the end that the plans and elevations are reproduced at a uniform scale. An exception can be made in the case of the general plan of a site, but an attempt should be made to keep everything else uniform.

709. It has been mentioned above that a reproduction reduction of one half is excellent. That enables the draftsman to use a convenient scale such as 1-100 and have it reproduced at 1-200, a scale that is also convenient to use. What should be avoided are reductions that will produce scales that do not appear on any standard rules and are therefore inconvenient to scale with a hand rule. The following are convenient scales: 1-10, 1-50, 1-100, 1-200, 1-400, 1-500, 1-1000, etc. The coarser scales are used for details of construction, while plans and elevations of buildings are often reproduced at 1-100 and 1-200, which means that they have been drawn at double that scale. The smaller scales are only used for the plans of entire sites or portions of them.

710. The major part of the architectural evidence is presented by means of plans and related sections. This is supplemented by a descriptive text. A complete plan of each building showing its condition at the end of the excavation, is the first and most important drawing required. This is usually made from, and at the same scale as, the survey sheets (1-100), which is large enough to include most of the detail that should appear in a plan. The plan should show clearly the materials used in the construction of the walls. In a stone wall, the type of masonry should be indicated. It is not necessary to draw in every stone, in fact it reduces the clarity of the drawing to do so; it is better to draw in occasional stones to give an idea of the general size and the type of stone cutting that is used in the wall. It will also be necessary to indicate the jointing around all doorways, windows, corners, and any special feature which might change the usual arrangement of the stones within a course. If any of these special conditions are too complicated to show at this scale, it is necessary to make additional drawings of just these elements. Isometric drawings have been found very useful in such cases since both the horizontal and vertical dimensions can be indicated with a high degree of accuracy. A similar technique can be used to indicate the use of sun-dried or baked brick.

711. The material used in the floors should be shown on this plan. Here again it is better if the material is indicated in a small area of the room and the whole floor not covered. This will make more legible any lettering that must be placed on the drawing, such as the numbers of the rooms. A device indicating the magnetic and true north must be drawn someplace where it will not interfere with the elements of the plan. With this plan drawn in such great detail it is possible to draw other plans that will show other occupational periods with much less detail and even at a smaller scale.

712. Carefully drawn sections at the scale of 1-100 should accompany the detailed plan just described. These should show the condition and height of the various walls at the time of excavation. It may be necessary to draw several section lines across the plan; they should be clearly indicated by use of a distinctive line such as a long dash and two dots which will not be confused with the lines reproducing architectural features. The ends of the section lines should be terminated by short lines with arrows at one end to indicate the direction of sight used to draw the portion of the section which is in elevation. Each line can be distinctly labelled by using pairs of letters, one at each arrow, which become the distinctive title of the section, e.g., Section AA.

713. Sections should be so selected that the relationship of all important structural and architectural elements such as benches, niches, doors, windows and steps can be shown in elevation or in section. The chief purpose of a section is to show relationships in levels just as a plan shows relationships on a horizontal plane.

714. If any special feature is too complicated to be treated at the scale suggested for the sections, additional details of such features should be drawn in a larger scale. Drawings of architectural fragments found in the debris, drawn at the scale of the special features (1-50), are often placed on the same sheet. These fragments are useful only if a detailed discussion is included in the text, giving all the information available as to their position in the plan, their relationship to the floor and their physical condition when excavated. There should be included here an estimate, made at the time of excavation by the architect who saw each fragment before its removal, as to the probable former position. Text cuts are sometimes used to bring the text and the drawings of the fragments together and are well worth the extra trouble.

715. The second phase of the task of preparing architectural remains for publication consists in making restorations of the building. These drawings are based primarily on the material presented in plans and sections showing the condition at the time of excavation. The major problem is to recreate the architecture of a given period so as to assist in the reconstruction of the social and economic life of the time. In a great many cases architecture is the chief evidence available and unfortunately it has been neglected much too often in the past. To take full advantage of the architecture it is necessary to do more than merely present the evidence of the material as it was found; reconstruction can and should be considered an important part of the publication.

716. If parts of the plan cannot be recovered, the architect's next duty is to restore the missing elements. Care should be taken to indicate clearly which portion has been restored, by using a different

system of cross hatching, or by merely drawing the outline of restored walls. This would be in vivid contrast to the rest of the plan where the material of the walls has been indicated. These restorations fall into two categories. The simpler is the type where only a corner or wall of a room is missing and the restoration is obvious. In the other type the extent of the restoration is so large that a number of solutions are possible. Here the architect should defend his restoration by reference to parallel material. This is as a rule more easily done with plans than with elevations since in a majority of publications, particularly of preclassical ages, little more than plans have ever been published. If no parallels can be found, a study of the rest of the plan will sometimes indicate whether or not an axial development has been used making a symmetrical treatment possible in the restoration. A close study of the condition of the ground in the neighborhood of the missing portion will sometimes indicate the practicability and extent of any early building.

717. The restored sections are generally developed from the sections showing the condition of the building at the time of the excavation. They can be separate drawings or the two objectives can be combined in one drawing. It is somewhat more difficult to differentiate between original and restored portions of the drawing in the sections than it is in the plans. It can be done if the drawing of the portion that was excavated is rendered, that is to say, if an attempt is made to show the difference in planes and materials by shading and by drawing the shadows that the projecting portion cast on other parts of the drawing. The restored section can then be drawn directly above the rendered portion in outline. The separation is made even more vivid if a narrow space is left between the two sections. (Figure No. 22)

The Use of Rendered Perspective and Isometric Drawings

718. Ordinary architectural drawings, showing straight elevations, plans and sections are not always intelligible to the layman, no matter how carefully labelled. This makes the reader who cannot differentiate between a plan and an elevation, completely dependent on the written text, which is a very poor substitute for a good set of drawings. The only solution to this problem is to combine all the evidence from plans, elevations, and sections in a perspective or isometric drawing. If properly presented, the atmosphere of the period can be recreated for the layman as successfully as if photographs were available from the period being studied. The use of perspectives is not new since the Germans especially prepared very elaborate line drawings for their various publications.

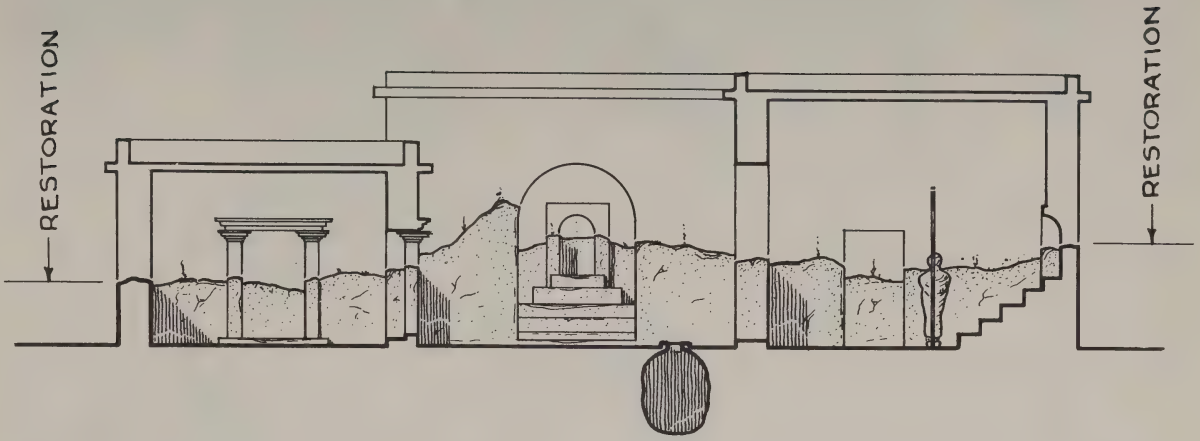


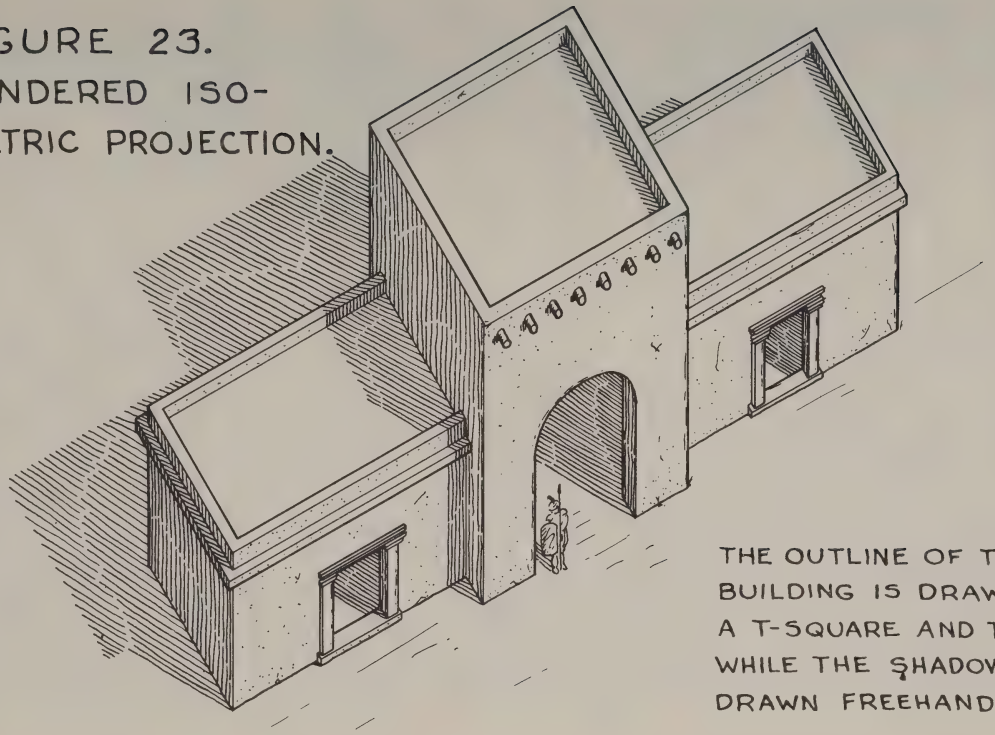
FIGURE 22. A TYPICAL SECTION THROUGH A BUILDING OF THE TYPE FOUND AT DURA-EUROPOS SHOWING RESTORED SECTION 'FLOATED' ON EXISTING RUINS.

The principal reason for not using them more widely has been the prohibitive cost of their preparation. The person who prepares the drawings must combine the skill of an architect and artist, and must also have some understanding and interest in the problems of the scholar. Obviously this combination of talents rarely appears and a person with only the first two abilities can rarely be interested in the modest pay afforded in the budget of a scholarly publication. The typical artist is likely to insist upon doing a wash drawing rather than a line drawing which, as observed earlier, will add materially to the cost of publication.

719. Since ordinary two-point perspective drawings are impractical, this method of presentation should be confined to the one-point type which are comparatively simple to make and lend themselves readily to details of buildings. Isometric projections have come into more general use in architects' offices and general publications where architectural drawings are used. At first glance they look like ordinary perspective and in fact some laymen are never able to tell them apart. Their great advantage lies in the ease and speed and therefore the cheapness of their production. Since they have no vanishing points they can be scaled in any dimension. A corner of the building is always toward the viewer in an isometric projection so that one side can be assumed to be in shadow. This will make effective rendering possible. A slight distortion will be noticeable to the eye accustomed to perspectives, but this can be alleviated by careful rendering that focuses attention on the central part of the drawing. Isometric projection can be used for views of large groups, single buildings or details of buildings. (Figure No. 23)

720. By this time it should be obvious that the type of reproduction most suitable for an archaeological publication is a line drawing. The various planes are delimited and the shadows indicated by the use of hachure. In plan some attempt should be made to indicate the materials with fine lines and dots varying in density. Shadows are shown with fine parallel lines drawn much as they are in an engraving. If the shadow falls over detail the spacing between the lines should be made wider. This hachure should be drawn with a freehand pen and is most successful when contrasted with other lines drawn with a ruling pen, T square and triangle, (see sketch). Before any rendering can be started by the hachure method, the ratio or reduction must be determined, and the density of lines, particularly those in shadow, arranged accordingly. If the lines are too close together for the ratio of reduction, the result will be a black mass rather than a tone.

FIGURE 23.
RENDERED ISO-
METRIC PROJECTION.



THE OUTLINE OF THE BUILDING IS DRAWN WITH A T-SQUARE AND TRIANGLE WHILE THE SHADOWS ARE DRAWN FREEHAND.

The Theory of Free Restoration

721. Very often the architect exhausts all sources in the process of restoring the architecture of a site. No parallels can be found in published material and the debris has not yielded sufficient evidence for the restoration of missing parts of the plans and the superstructure of excavated buildings. Restorations are, therefore, completely freed from the restraints ordinarily imposed by scholarly approach.

722. In general the architect may assume that in parts of the world which have tended to resist improvement, where it is obvious that little change has taken place in centuries, building techniques have changed very little. Fortunately, most archaeological investigation have taken place in such regions, mainly because large areas of ground can be rented or bought and uncovered at a reasonable price. It may also be assumed that the climate has varied but little so that the methods of coping with the extremities of climatic change are much the same. Materials available for building will not vary too much except that wood has become less abundant as time has passed. In desert areas, of course, there never was much wood.

723. With the example of present-day building in the area and the aid of a few general principles that have guided the builder since the first structures were erected by man, it is possible to restore almost any building within reasonably conjectural limits. The height of a wall varies, depending on the stability gained by its width at the base and the type of construction used. If two walls are uncovered of different width but made of the same material, it is obvious that the wider wall was higher. It may also be assumed that a stone wall strengthened by the use of headers and quoins at the corner and openings was higher than a neighboring wall built at the same time without these strengthening devices. (Figure No. 24)

724. It may be assumed that doorways were meant to be large enough to walk through. It has been found that in general doorways were usually built in such proportions that the height equals twice the width. Windows were rare in the early period and if used were small, to keep out the glare in the hot season and the cold in other climates and seasons. Window glass was not available and was not used until the Roman period.

725. Walls of buildings that contained vaults are usually found to be thicker, particularly under the springing of the vault. (The place from which the vault rises is called the springing line). This was found to be necessary, no doubt, by the first people to use a vault or arch, when they discovered by experience that the weight of an

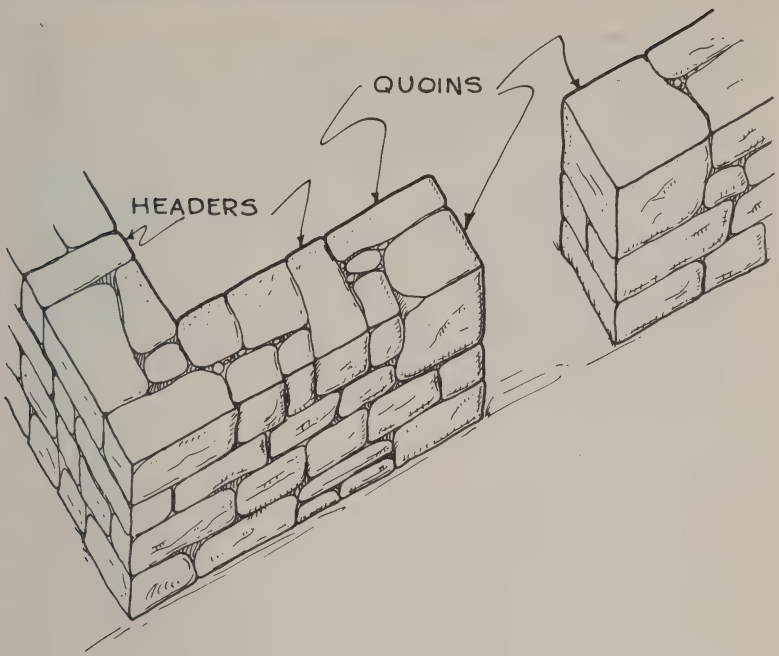


FIGURE 2'4.
WALL WITH QUOINS
AND HEADERS.

arch or vault does not descend vertically in a wall but rather at an angle away from the base of the wall. This weight, called the thrust, must be absorbed by increasing the thickness of the wall in order to maintain stability or to keep the building from collapsing. In addition the walls were sometimes battered or sloped on both faces to increase this effect. Not all battered walls that are found can be assumed to have held vaults however, since this was a common practice in erecting dry walls or walls without mortar. This was and still is necessary in the erection of dry walls of rough polygonal masonry and mud brick. Examples are occasionally found of the use of the buttress, in an attempt to strengthen a wall by adding to its width only at the place where the diagonal thrust of an arch was to be compensated. These buttresses were usually battered. The technique of battering or sloping the surface of a wall became a fixed tradition in Egyptian architecture even though the walls were made of ashlar or rectangular shaped stones properly bedded.

726. Where vaults were used, the springing lines were usually above the highest opening. The vaults sometimes were not visible from the exterior. Flat roofs were usually made of timber and reeds covered with mud or lime mortar. Trees were often planted for the express purpose of being used as roof beams. Often such timbers were of a kind of tree which could not be sawed for boards.

727. Again climatic conditions do and always have influenced roof construction. The amount and frequency of rainfall will determine the type of roofing material used. It must also be remembered that roofs have always been used in hot climates for living and sleeping purposes. This must be taken into account and sufficient thickness allowed in restoring roof timbers or vaults. This may affect the height of the elevations.

APPENDIX

I

TABLE I

Mantissas of Common Logarithms of Numbers to Five Decimal Places

TABLE I

100-150

N.	0	1	2	3	4	5	6	7	8	9
100	00 000	043	087	130	173	217	260	303	346	389
101	432	475	518	561	604	647	689	732	775	817
102	860	903	945	988	*030	*072	*115	*157	*199	*242
103	01 284	326	368	410	452	494	536	578	620	662
104	703	745	787	828	870	912	953	995	*036	*078
105	02 119	160	202	243	284	325	366	407	449	490
106	531	572	612	653	694	735	776	816	857	898
107	938	979	*019	*060	*100	*141	*181	*222	*262	*302
108	03 342	383	423	463	503	543	583	623	663	703
109	743	782	822	862	902	941	981	*021	*060	*100
110	04 139	179	218	258	297	336	376	415	454	493
111	532	571	610	650	689	727	766	805	844	883
112	922	961	999	*038	*077	*115	*154	*192	*231	*269
113	05 308	346	385	423	461	500	538	576	614	652
114	690	729	767	805	843	881	918	956	994	*032
115	06 070	108	145	183	221	258	296	333	371	408
116	446	483	521	558	595	633	670	707	744	781
117	819	856	893	930	967	*004	*041	*078	*115	*151
118	07 188	225	262	298	335	372	408	445	482	518
119	555	591	628	664	700	737	773	809	846	882
120	918	954	990	*027	*063	*099	*135	*171	*207	*243
121	08 279	314	350	386	422	458	493	529	565	600
122	636	672	707	743	778	814	849	884	920	955
123	991	*026	*061	*096	*132	*167	*202	*237	*272	*307
124	09 342	377	412	447	482	517	552	587	621	656
125	691	726	760	795	830	864	899	934	968	*003
126	10 037	072	106	140	175	209	243	278	312	346
127	380	415	449	483	517	551	585	619	653	687
128	721	755	789	823	857	890	924	958	992	*025
129	11 059	093	126	160	193	227	261	294	327	361
130	394	428	461	494	528	561	594	628	661	694
131	727	760	793	826	860	893	926	959	992	*024
132	12 057	090	123	156	189	222	254	287	320	352
133	385	418	450	483	516	548	581	613	646	678
134	710	743	775	808	840	872	905	937	969	*001
135	13 033	066	098	130	162	194	226	258	290	322
136	354	386	418	450	481	513	545	577	609	640
137	672	704	735	767	799	830	862	893	925	956
138	988	*019	*051	*082	*114	*145	*176	*208	*239	*270
139	14 301	333	364	395	426	457	489	520	551	582
140	613	644	675	706	737	768	799	829	860	891
141	922	953	983	*014	*045	*076	*106	*137	*168	*198
142	15 229	259	290	320	351	381	412	442	473	503
143	534	564	594	625	655	685	715	746	776	806
144	836	866	897	927	957	987	*017	*047	*077	*107
145	16 137	167	197	227	256	286	316	346	376	406
146	435	465	495	524	554	584	613	643	673	702
147	732	761	791	820	850	879	909	938	967	997
148	17 026	056	085	114	143	173	202	231	260	289
149	319	348	377	406	435	464	493	522	551	580
150	609	638	667	696	725	754	782	811	840	869
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Prop. Pts.			
	44	**43**	**42**
1	4.4	4.3	4.2
2	8.8	8.6	8.4
3	13.2	12.9	12.6
4	17.6	17.2	16.8
5	22.0	21.5	21.0
6	26.4	25.8	25.2
7	30.8	30.1	29.4
8	35.2	34.4	33.6
9	39.6	38.7	37.8
	41	**40**	**39**
1	4.1	4.0	3.9
2	8.2	8.0	7.8
3	12.3	12.0	11.7
4	16.4	16.0	15.6
5	20.5	20.0	19.5
6	24.6	24.0	23.4
7	28.7	28.0	27.3
8	32.8	32.0	31.2
9	36.9	36.0	35.1
	38	**37**	**36**
1	3.8	3.7	3.6
2	7.6	7.4	7.2
3	11.4	11.1	10.8
4	15.2	14.8	14.4
5	19.0	18.5	18.0
6	22.8	22.2	21.6
7	26.6	25.9	25.2
8	30.4	29.6	28.8
9	34.2	33.3	32.4
	35	**34**	**33**
1	3.5	3.4	3.3
2	7.0	6.8	6.6
3	10.5	10.2	9.9
4	14.0	13.6	13.2
5	17.5	17.0	16.5
6	21.0	20.4	19.8
7	24.5	23.8	23.1
8	28.0	27.2	26.4
9	31.5	30.6	29.7
	32	**31**	**30**
1	3.2	3.1	3.0
2	6.4	6.2	6.0
3	9.6	9.3	9.0
4	12.8	12.4	12.0
5	16.0	15.5	15.0
6	19.2	18.6	18.0
7	22.4	21.7	21.0
8	25.6	24.8	24.0
9	28.8	27.9	27.0

Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
150	17 609	638	667	696	725	754	782	811	840	869	
151	898	926	955	984	*013	*041	*070	*099	*127	*156	**29** **28**
152	18 184	213	241	270	298	327	355	384	412	441	1 2.9 2.8
153	469	498	526	554	583	611	639	667	696	724	2 5.8 5.6
											3 8.7 8.4
154	752	780	808	837	865	893	921	949	977	*005	4 11.6 11.2
155	19 033	061	089	117	145	173	201	229	257	285	5 14.5 14.0
156	312	340	368	396	424	451	479	507	535	562	6 17.4 16.8
											7 20.3 19.6
157	590	618	645	673	700	728	756	783	811	838	8 23.2 22.4
158	866	893	921	948	976	*003	*030	*058	*085	*112	9 26.1 25.2
159	20 140	167	194	222	249	276	303	330	358	385	
160	412	439	466	493	520	548	575	602	629	656	
161	683	710	737	763	790	817	844	871	898	925	**27** **26**
162	952	978	*005	*032	*059	*085	*112	*139	*165	*192	1 2.7 2.6
163	21 219	245	272	299	325	352	378	405	431	458	2 5.4 5.2
											3 8.1 7.8
164	484	511	537	564	590	617	643	669	696	722	4 10.8 10.4
165	748	775	801	827	854	880	906	932	958	985	5 13.5 13.0
166	22 011	037	063	089	115	141	167	194	220	246	6 16.2 15.6
											7 18.9 18.2
167	272	298	324	350	376	401	427	453	479	505	8 21.6 20.8
168	531	557	583	608	634	660	686	712	737	763	9 24.3 23.4
169	789	814	840	866	891	917	943	968	994	*019	
170	23 045	070	096	121	147	172	198	223	249	274	
171	300	325	350	376	401	426	452	477	502	528	**25**
172	553	578	603	629	654	679	704	729	754	779	1 2.5
173	805	830	855	880	905	930	955	980	*005	*030	2 5.0
											3 7.5
174	24 055	080	105	130	155	180	204	229	254	279	4 10.0
175	304	329	353	378	403	428	452	477	502	527	5 12.5
176	551	576	601	625	650	674	699	724	748	773	6 15.0
											7 17.5
177	797	822	846	871	895	920	944	969	993	*018	8 20.0
178	25 042	066	091	115	139	164	188	212	237	261	9 22.5
179	285	310	334	358	382	406	431	455	479	503	
180	527	551	575	600	624	648	672	696	720	744	
181	768	792	816	840	864	888	912	935	959	983	**24** **23**
182	26 007	031	055	079	102	126	150	174	198	221	1 2.4 2.3
183	245	269	293	316	340	364	387	411	435	458	2 4.8 4.6
											3 7.2 6.9
184	482	505	529	553	576	600	623	647	670	694	4 9.6 9.2
185	717	741	764	788	811	834	858	881	905	928	5 12.0 11.5
186	951	975	998	*021	*045	*068	*091	*114	*138	*161	6 14.4 13.8
											7 16.8 16.1
187	27 184	207	231	254	277	300	323	346	370	393	8 19.2 18.4
188	416	439	462	485	508	531	554	577	600	623	9 21.6 20.7
189	646	669	692	715	738	761	784	807	830	852	
190	875	898	921	944	967	989	*012	*035	*058	*081	
191	28 103	126	149	171	194	217	240	262	285	307	**22** **21**
192	330	353	375	398	421	443	466	488	511	533	1 2.2 2.1
193	556	578	601	623	646	668	691	713	735	758	2 4.4 4.2
											3 6.6 6.3
194	780	803	825	847	870	892	914	937	959	981	4 8.8 8.4
195	29 003	026	048	070	092	115	137	159	181	203	5 11.0 10.5
196	226	248	270	292	314	336	358	380	403	425	6 13.2 12.6
											7 15.4 14.7
197	447	469	491	513	535	557	579	601	623	645	8 17.6 16.8
198	667	688	710	732	754	776	798	820	842	863	9 19.8 18.9
199	885	907	929	951	973	994	*016	*038	*060	*081	
200	30 103	125	146	168	190	211	233	255	276	298	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

TABLE I **200-250**

N.	0	1	2	3	4	5	6	7	8	9
200	30 103	125	146	168	190	211	233	255	276	298
201	320	341	363	384	406	428	449	471	492	514
202	535	557	578	600	621	643	664	685	707	728
203	750	771	792	814	835	856	878	899	920	942
204	963	984	*006	*027	*048	*069	*091	*112	*133	*154
205	31 175	197	218	239	260	281	302	323	345	366
206	387	408	429	450	471	492	513	534	555	576
207	597	618	639	660	681	702	723	744	765	785
208	806	827	848	869	890	911	931	952	973	994
209	32 015	035	056	077	098	118	139	160	181	201
210	222	243	263	284	305	325	346	366	387	408
211	428	449	469	490	510	531	552	572	593	613
212	634	654	675	695	715	736	756	777	797	818
213	838	858	879	899	919	940	960	980	*001	*021
214	33 041	062	082	102	122	143	163	183	203	224
215	244	264	284	304	325	345	365	385	405	425
216	445	465	486	506	526	546	566	586	606	626
217	646	666	686	706	726	746	766	786	806	826
218	846	866	885	905	925	945	965	985	*005	*025
219	34 044	064	084	104	124	143	163	183	203	223
220	242	262	282	301	321	341	361	380	400	420
221	439	459	479	498	518	537	557	577	596	616
222	635	655	674	694	713	733	753	772	792	811
223	830	850	869	889	908	928	947	967	986	*005
224	35 025	044	064	083	102	122	141	160	180	199
225	218	238	257	276	295	315	334	353	372	392
226	411	430	449	468	488	507	526	545	564	583
227	603	622	641	660	679	698	717	736	755	774
228	793	813	832	851	870	889	908	927	946	965
229	984	*003	*021	*040	*059	*078	*097	*116	*135	*154
230	36 173	192	211	229	248	267	286	305	324	342
231	361	380	399	418	436	455	474	493	511	530
232	549	568	586	605	624	642	661	680	698	717
233	736	754	773	791	810	829	847	866	884	903
234	922	940	959	977	996	*014	*033	*051	*070	*088
235	37 107	125	144	162	181	199	218	236	254	273
236	291	310	328	346	365	383	401	420	438	457
237	475	493	511	530	548	566	585	603	621	639
238	658	676	694	712	731	749	767	785	803	822
239	840	858	876	894	912	931	949	967	985	*003
240	38 021	039	057	075	093	112	130	148	166	184
241	202	220	238	256	274	292	310	328	346	364
242	382	399	417	435	453	471	489	507	525	543
243	561	578	596	614	632	650	668	686	703	721
244	739	757	775	792	810	828	846	863	881	899
245	917	934	952	970	987	*005	*023	*041	*058	*076
246	39 094	111	129	146	164	182	199	217	235	252
247	270	287	305	322	340	358	375	393	410	428
248	445	463	480	498	515	533	550	568	585	602
249	620	637	655	672	690	707	724	742	759	777
250	794	811	829	846	863	881	898	915	933	950
N.	0	1	2	3	4	5	6	7	8	9

Prop. Pts.		
	22	**21**
1	2.2	2.1
2	4.4	4.2
3	6.6	6.3
4	8.8	8.4
5	11.0	10.5
6	13.2	12.6
7	15.4	14.7
8	17.6	16.8
9	19.8	18.9

	20
1	2.0
2	4.0
3	6.0
4	8.0
5	10.0
6	12.0
7	14.0
8	16.0
9	18.0

	19
1	1.9
2	3.8
3	5.7
4	7.6
5	9.5
6	11.4
7	13.3
8	15.2
9	17.1

	18
1	1.8
2	3.6
3	5.4
4	7.2
5	9.0
6	10.8
7	12.6
8	14.4
9	16.2

	17
1	1.7
2	3.4
3	5.1
4	6.8
5	8.5
6	10.2
7	11.9
8	13.6
9	15.3

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
250	39 794	811	829	846	863	881	898	915	933	950	
251	967	985	*002	*019	*037	*054	*071	*088	*106	*123	18
252	40 140	157	175	192	209	226	243	261	278	295	1 1.8
253	312	329	346	364	381	398	415	432	449	466	2 3.6
											3 5.4
254	483	500	518	535	552	569	586	603	620	637	4 7.2
255	654	671	688	705	722	739	756	773	790	807	5 9.0
256	824	841	858	875	892	909	926	943	960	976	6 10.8
											7 12.6
257	993	*010	*027	*044	*061	*078	*095	*111	*128	*145	8 14.4
258	41 162	179	196	212	229	246	263	280	296	313	9 16.2
259	330	347	363	380	397	414	430	447	464	481	
260	497	514	531	547	564	581	597	614	631	647	
261	664	681	697	714	731	747	764	780	797	814	17
262	830	847	863	880	896	913	929	946	963	979	1 1.7
263	996	*012	*029	*045	*062	*078	*095	*111	*127	*144	2 3.4
											3 5.1
264	42 160	177	193	210	226	243	259	275	292	308	4 6.8
265	325	341	357	374	390	406	423	439	455	472	5 8.5
266	488	504	521	537	553	570	586	602	619	635	6 10.2
											7 11.9
267	651	667	684	700	716	732	749	765	781	797	8 13.6
268	813	830	846	862	878	894	911	927	943	959	9 15.3
269	975	991	*008	*024	*040	*056	*072	*088	*104	*120	
270	43 136	152	169	185	201	217	233	249	265	281	log e = 0.43429
271	297	313	329	345	361	377	393	409	425	441	
272	457	473	489	505	521	537	553	569	584	600	16
273	616	632	648	664	680	696	712	727	743	759	1 1.6
											2 3.2
274	775	791	807	823	838	854	870	886	902	917	3 4.8
275	933	949	965	981	996	*012	*028	*044	*059	*075	4 6.4
276	44 091	107	122	138	154	170	185	201	217	232	5 8.0
											6 9.6
277	248	264	279	295	311	326	342	358	373	389	7 11.2
278	404	420	436	451	467	483	498	514	529	545	8 12.8
279	560	576	592	607	623	638	654	669	685	700	9 14.4
280	716	731	747	762	778	793	809	824	840	855	
281	871	886	902	917	932	948	963	979	994	*010	15
282	45 025	040	056	071	086	102	117	133	148	163	1 1.5
283	179	194	209	225	240	255	271	286	301	317	2 3.0
											3 4.5
284	332	347	362	378	393	408	423	439	454	469	4 6.0
285	484	500	515	530	545	561	576	591	606	621	5 7.5
286	637	652	667	682	697	712	728	743	758	773	6 9.0
											7 10.5
287	788	803	818	834	849	864	879	894	909	924	8 12.0
288	939	954	969	984	*000	*015	*030	*045	*060	*075	9 13.5
289	46 090	105	120	135	150	165	180	195	210	225	
290	240	255	270	285	300	315	330	345	359	374	
291	389	404	419	434	449	464	479	494	509	523	14
292	538	553	568	583	598	613	627	642	657	672	1 1.4
293	687	702	716	731	746	761	776	790	805	820	2 2.8
											3 4.2
294	835	850	864	879	894	909	923	938	953	967	4 5.6
295	982	997	*012	*026	*041	*056	*070	*085	*100	*114	5 7.0
296	47 129	144	159	173	188	202	217	232	246	261	6 8.4
											7 9.8
297	276	290	305	319	334	349	363	378	392	407	8 11.2
298	422	436	451	465	480	494	509	524	538	553	9 12.6
299	567	582	596	611	625	640	654	669	683	698	
300	712	727	741	756	770	784	799	813	828	842	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

TABLE I

300-350

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
300	47 712	727	741	756	770	784	799	813	828	842	
301	857	871	885	900	914	929	943	958	972	986	
302	48 001	015	029	044	058	073	087	101	116	130	
303	144	159	173	187	202	216	230	244	259	273	**15**
304	287	302	316	330	344	359	373	387	401	416	1 1.5
305	430	444	458	473	487	501	515	530	544	558	2 3.0
306	572	586	601	615	629	643	657	671	686	700	3 4.5
307	714	728	742	756	770	785	799	813	827	841	4 6.0
308	855	869	883	897	911	926	940	954	968	982	5 7.5
309	996	*010	*024	*038	*052	*066	*080	*094	*108	*122	6 9.0
310	49 136	150	164	178	192	206	220	234	248	262	7 10.5
311	276	290	304	318	332	346	360	374	388	402	8 12.0
312	415	429	443	457	471	485	499	513	527	541	9 13.5
313	554	568	582	596	610	624	638	651	665	679	
314	693	707	721	734	748	762	776	790	803	817	$\log \pi = 0.49715$
315	831	845	859	872	886	900	914	927	941	955	
316	969	982	996	*010	*024	*037	*051	*065	*079	*092	
317	50 106	120	133	147	161	174	188	202	215	229	**14**
318	243	256	270	284	297	311	325	338	352	365	1 1.4
319	379	393	406	420	433	447	461	474	488	501	2 2.8
320	515	529	542	556	569	583	596	610	623	637	3 4.2
321	651	664	678	691	705	718	732	745	759	772	4 5.6
322	786	799	813	826	840	853	866	880	893	907	5 7.0
323	920	934	947	961	974	987	*001	*014	*028	*041	6 8.4
324	51 055	068	081	095	108	121	135	148	162	175	7 9.8
325	188	202	215	228	242	255	268	282	295	308	8 11.2
326	322	335	348	362	375	388	402	415	428	441	9 12.6
327	455	468	481	495	508	521	534	548	561	574	
328	587	601	614	627	640	654	667	680	693	706	
329	720	733	746	759	772	786	799	812	825	838	**13**
330	851	865	878	891	904	917	930	943	957	970	1 1.3
331	983	996	*009	*022	*035	*048	*061	*075	*088	*101	2 2.6
332	52 114	127	140	153	166	179	192	205	218	231	3 3.9
333	244	257	270	284	297	310	323	336	349	362	4 5.2
334	375	388	401	414	427	440	453	466	479	492	5 6.5
335	504	517	530	543	556	569	582	595	608	621	6 7.8
336	634	647	660	673	686	699	711	724	737	750	7 9.1
337	763	776	789	802	815	827	840	853	866	879	8 10.4
338	892	905	917	930	943	956	969	982	994	*007	9 11.7
339	53 020	033	046	058	071	084	097	110	122	135	
340	148	161	173	186	199	212	224	237	250	263	**12**
341	275	288	301	314	326	339	352	364	377	390	1 1.2
342	403	415	428	441	453	466	479	491	504	517	2 2.4
343	529	542	555	567	580	593	605	618	631	643	3 3.6
344	656	668	681	694	706	719	732	744	757	769	4 4.8
345	782	794	807	820	832	845	857	870	882	895	5 6.0
346	908	920	933	945	958	970	983	995	*008	*020	6 7.2
347	54 033	045	058	070	083	095	108	120	133	145	7 8.4
348	158	170	183	195	208	220	233	245	258	270	8 9.6
349	283	295	307	320	332	345	357	370	382	394	9 10.8
350	407	419	432	444	456	469	481	494	506	518	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
350	54 407	419	432	444	456	469	481	494	506	518	
351	531	543	555	568	580	593	605	617	630	642	
352	654	667	679	691	704	716	728	741	753	765	
353	777	790	802	814	827	839	851	864	876	888	
354	900	913	925	937	949	962	974	986	998	*011	13
355	55 023	035	047	060	072	084	096	108	121	133	1 1.3
356	145	157	169	182	194	206	218	230	242	255	2 2.6
357	267	279	291	303	315	328	340	352	364	376	3 3.9
358	388	400	413	425	437	449	461	473	485	497	4 5.2
359	509	522	534	546	558	570	582	594	606	618	5 6.5
360	630	642	654	666	678	691	703	715	727	739	6 7.8
361	751	763	775	787	799	811	823	835	847	859	7 9.1
362	871	883	895	907	919	931	943	955	967	979	8 10.4
363	991	*003	*015	*027	*038	*050	*062	*074	*086	*098	9 11.7
364	56 110	122	134	146	158	170	182	194	205	217	
365	229	241	253	265	277	289	301	312	324	336	12
366	348	360	372	384	396	407	419	431	443	455	1 1.2
367	467	478	490	502	514	526	538	549	561	573	2 2.4
368	585	597	608	620	632	644	656	667	679	691	3 3.6
369	703	714	726	738	750	761	773	785	797	808	4 4.8
370	820	832	844	855	867	879	891	902	914	926	5 6.0
371	937	949	961	972	984	996	*008	*019	*031	*043	6 7.2
372	57 054	066	078	089	101	113	124	136	148	159	7 8.4
373	171	183	194	206	217	229	241	252	264	276	8 9.6
374	287	299	310	322	334	345	357	368	380	392	9 10.8
375	403	415	426	438	449	461	473	484	496	507	
376	519	530	542	553	565	576	588	600	611	623	
377	634	646	657	669	680	692	703	715	726	738	11
378	749	761	772	784	795	807	818	830	841	852	1 1.1
379	864	875	887	898	910	921	933	944	955	967	2 2.2
380	978	990	*001	*013	*024	*035	*047	*058	*070	*081	3 3.3
381	58 092	104	115	127	138	149	161	172	184	195	4 4.4
382	206	218	229	240	252	263	274	286	297	309	5 5.5
383	320	331	343	354	365	377	388	399	410	422	6 6.6
384	433	444	456	467	478	490	501	512	524	535	7 7.7
385	546	557	569	580	591	602	614	625	636	647	8 8.8
386	659	670	681	692	704	715	726	737	749	760	9 9.9
387	771	782	794	805	816	827	838	850	861	872	
388	883	894	906	917	928	939	950	961	973	984	
389	995	*006	*017	*028	*040	*051	*062	*073	*084	*095	10
390	59 106	118	129	140	151	162	173	184	195	207	1 1.0
391	218	229	240	251	262	273	284	295	306	318	2 2.0
392	329	340	351	362	373	384	395	406	417	428	3 3.0
393	439	450	461	472	483	494	506	517	528	539	4 4.0
394	550	561	572	583	594	605	616	627	638	649	5 5.0
395	660	671	682	693	704	715	726	737	748	759	6 6.0
396	770	780	791	802	813	824	835	846	857	868	7 7.0
397	879	890	901	912	923	934	945	956	966	977	8 8.0
398	988	999	*010	*021	*032	*043	*054	*065	*076	*086	9 9.0
399	60 097	108	119	130	141	152	163	173	184	195	
400	206	217	228	239	249	260	271	282	293	304	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

TABLE I

400-450

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
400	60 206	217	228	239	249	260	271	282	293	304	
401	314	325	336	347	358	369	379	390	401	412	
402	423	433	444	455	466	477	487	498	509	520	
403	531	541	552	563	574	584	595	606	617	627	
404	638	649	660	670	681	692	703	713	724	735	
405	746	756	767	778	788	799	810	821	831	842	
406	853	863	874	885	895	906	917	927	938	949	
407	959	970	981	991	*002	*013	*023	*034	*045	*055	11 | 1 1.1 | 2 2.2 | 3 3.3 | 4 4.4 | 5 5.5 | 6 6.6 | 7 7.7 | 8 8.8 | 9 9.9
408	61 066	077	087	098	109	119	130	140	151	162	
409	172	183	194	204	215	225	236	247	257	268	
410	278	289	300	310	321	331	342	352	363	374	
411	384	395	405	416	426	437	448	458	469	479	
412	490	500	511	521	532	542	553	563	574	584	
413	595	606	616	627	637	648	658	669	679	690	
414	700	711	721	731	742	752	763	773	784	794	
415	805	815	826	836	847	857	868	878	888	899	
416	909	920	930	941	951	962	972	982	993	*003	
417	62 014	024	034	045	055	066	076	086	097	107	
418	118	128	138	149	159	170	180	190	201	211	
419	221	232	242	252	263	273	284	294	304	315	
420	325	335	346	356	366	377	387	397	408	418	
421	428	439	449	459	469	480	490	500	511	521	10 | 1 1.0 | 2 2.0 | 3 3.0 | 4 4.0 | 5 5.0 | 6 6.0 | 7 7.0 | 8 8.0 | 9 9.0
422	531	542	552	562	572	583	593	603	613	624	
423	634	644	655	665	675	685	696	706	716	726	
424	737	747	757	767	778	788	798	808	818	829	
425	839	849	859	870	880	890	900	910	921	931	
426	941	951	961	972	982	992	*002	*012	*022	*033	
427	63 043	053	063	073	083	094	104	114	124	134	
428	144	155	165	175	185	195	205	215	225	236	
429	246	256	266	276	286	296	306	317	327	337	
430	347	357	367	377	387	397	407	417	428	438	
431	448	458	468	478	488	498	508	518	528	538	
432	548	558	568	579	589	599	609	619	629	639	
433	649	659	669	679	689	699	709	719	729	739	
434	749	759	769	779	789	799	809	819	829	839	
435	849	859	869	879	889	899	909	919	929	939	
436	949	959	969	979	988	998	*008	*018	*028	*038	
437	64 048	058	068	078	088	098	108	118	128	137	9 | 1 0.9 | 2 1.8 | 3 2.7 | 4 3.6 | 5 4.5 | 6 5.4 | 7 6.3 | 8 7.2 | 9 8.1
438	147	157	167	177	187	197	207	217	227	237	
439	246	256	266	276	286	296	306	316	326	335	
440	345	355	365	375	385	395	404	414	424	434	
441	444	454	464	473	483	493	503	513	523	532	
442	542	552	562	572	582	591	601	611	621	631	
443	640	650	660	670	680	689	699	709	719	729	
444	738	748	758	768	777	787	797	807	816	826	
445	836	846	856	865	875	885	895	904	914	924	
446	933	943	953	963	972	982	992	*002	*011	*021	
447	65 031	040	050	060	070	079	089	099	108	118	
448	128	137	147	157	167	176	186	196	205	215	
449	225	234	244	254	263	273	283	292	302	312	
450	321	331	341	350	360	369	379	389	398	408	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
450	65 321	331	341	350	360	369	379	389	398	408	
451	418	427	437	447	456	466	475	485	495	504	
452	514	523	533	543	552	562	571	581	591	600	
453	610	619	629	639	648	658	667	677	686	696	
454	706	715	725	734	744	753	763	772	782	792	
455	801	811	820	830	839	849	858	868	877	887	
456	896	906	916	925	935	944	954	963	973	982	10 | 1 1.0 2 2.0 3 3.0 4 4.0 5 5.0 6 6.0 7 7.0 8 8.0 9 9.0
457	992	*001	*011	*020	*030	*039	*049	*058	*068	*077	
458	66 087	096	106	115	124	134	143	153	162	172	
459	181	191	200	210	219	229	238	247	257	266	
460	276	285	295	304	314	323	332	342	351	361	
461	370	380	389	398	408	417	427	436	445	455	
462	464	474	483	492	502	511	521	530	539	549	
463	558	567	577	586	596	605	614	624	633	642	
464	652	661	671	680	689	699	708	717	727	736	
465	745	755	764	773	783	792	801	811	820	829	
466	839	848	857	867	876	885	894	904	913	922	
467	932	941	950	960	969	978	987	997	*006	*015	
468	67 025	034	043	052	062	071	080	089	099	108	
469	117	127	136	145	154	164	173	182	191	201	
470	210	219	228	237	247	256	265	274	284	293	
471	302	311	321	330	339	348	357	367	376	385	9 | 1 0.9 2 1.8 3 2.7 4 3.6 5 4.5 6 5.4 7 6.3 8 7.2 9 8.1
472	394	403	413	422	431	440	449	459	468	477	
473	486	495	504	514	523	532	541	550	560	569	
474	578	587	596	605	614	624	633	642	651	660	
475	669	679	688	697	706	715	724	733	742	752	
476	761	770	779	788	797	806	815	825	834	843	
477	852	861	870	879	888	897	906	916	925	934	
478	943	952	961	970	979	988	997	*006	*015	*024	
479	68 034	043	052	061	070	079	088	097	106	115	
480	124	133	142	151	160	169	178	187	196	205	
481	215	224	233	242	251	260	269	278	287	296	
482	305	314	323	332	341	350	359	368	377	386	
483	395	404	413	422	431	440	449	458	467	476	
484	485	494	502	511	520	529	538	547	556	565	
485	574	583	592	601	610	619	628	637	646	655	
486	664	673	681	690	699	708	717	726	735	744	8 | 1 0.8 2 1.6 3 2.4 4 3.2 5 4.0 6 4.8 7 5.6 8 6.4 9 7.2
487	753	762	771	780	789	797	806	815	824	833	
488	842	851	860	869	878	886	895	904	913	922	
489	931	940	949	958	966	975	984	993	*002	*011	
490	69 020	028	037	046	055	064	073	082	090	099	
491	108	117	126	135	144	152	161	170	179	188	
492	197	205	214	223	232	241	249	258	267	276	
493	285	294	302	311	320	329	338	346	355	364	
494	373	381	390	399	408	417	425	434	443	452	
495	461	469	478	487	496	504	513	522	531	539	
496	548	557	566	574	583	592	601	609	618	627	
497	636	644	653	662	671	679	688	697	705	714	
498	723	732	740	749	758	767	775	784	793	801	
499	810	819	827	836	845	854	862	871	880	888	
500	897	906	914	923	932	940	949	958	966	975	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

TABLE I

500-550

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
500	69 897	906	914	923	932	940	949	958	966	975	
501	984	992	*001	*010	*018	*027	*036	*044	*053	*062	
502	70 070	079	088	096	105	114	122	131	140	148	
503	157	165	174	183	191	200	209	217	226	234	
504	243	252	260	269	278	286	295	303	312	321	
505	329	338	346	355	364	372	381	389	398	406	
506	415	424	432	441	449	458	467	475	484	492	
507	501	509	518	526	535	544	552	561	569	578	9 | 1 0.9
508	586	595	603	612	621	629	638	646	655	663	2 1.8
509	672	680	689	697	706	714	723	731	740	749	3 2.7
510	757	766	774	783	791	800	808	817	825	834	4 3.6
511	842	851	859	868	876	885	893	902	910	919	5 4.5
512	927	935	944	952	961	969	978	986	995	*003	6 5.4
513	71 012	020	029	037	046	054	063	071	079	088	7 6.3
514	096	105	113	122	130	139	147	155	164	172	8 7.2
515	181	189	198	206	214	223	231	240	248	257	9 8.1
516	265	273	282	290	299	307	315	324	332	341	
517	349	357	366	374	383	391	399	408	416	425	
518	433	441	450	458	466	475	483	492	500	508	
519	517	525	533	542	550	559	567	575	584	592	
520	600	609	617	625	634	642	650	659	667	675	
521	684	692	700	709	717	725	734	742	750	759	8
522	767	775	784	792	800	809	817	825	834	842	1 0.8
523	850	858	867	875	883	892	900	908	917	925	2 1.6
524	933	941	950	958	966	975	983	991	999	*008	3 2.4
525	72 016	024	032	041	049	057	066	074	082	090	4 3.2
526	099	107	115	123	132	140	148	156	165	173	5 4.0
527	181	189	198	206	214	222	230	239	247	255	6 4.8
528	263	272	280	288	296	304	313	321	329	337	7 5.6
529	346	354	362	370	378	387	395	403	411	419	8 6.4
530	428	436	444	452	460	469	477	485	493	501	9 7.2
531	509	518	526	534	542	550	558	567	575	583	
532	591	599	607	616	624	632	640	648	656	665	
533	673	681	689	697	705	713	722	730	738	746	
534	754	762	770	779	787	795	803	811	819	827	
535	835	843	852	860	868	876	884	892	900	908	
536	916	925	933	941	949	957	965	973	981	989	
537	997	*006	*014	*022	*030	*038	*046	*054	*062	*070	7
538	73 078	086	094	102	111	119	127	135	143	151	1 0.7
539	159	167	175	183	191	199	207	215	223	231	2 1.4
540	239	247	255	263	272	280	288	296	304	312	3 2.1
541	320	328	336	344	352	360	368	376	384	392	4 2.8
542	400	408	416	424	432	440	448	456	464	472	5 3.5
543	480	488	496	504	512	520	528	536	544	552	6 4.2
544	560	568	576	584	592	600	608	616	624	632	7 4.9
545	640	648	656	664	672	679	687	695	703	711	8 5.6
546	719	727	735	743	751	759	767	775	783	791	9 6.3
547	799	807	815	823	830	838	846	854	862	870	
548	878	886	894	902	910	918	926	933	941	949	
549	957	965	973	981	989	997	*005	*013	*020	*028	
550	74 036	044	052	060	068	076	084	092	099	107	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
550	74 036	044	052	060	068	076	084	092	099	107	
551	115	123	131	139	147	155	162	170	178	186	
552	194	202	210	218	225	233	241	249	257	265	
553	273	280	288	296	304	312	320	327	335	343	
554	351	359	367	374	382	390	398	406	414	421	
555	429	437	445	453	461	468	476	484	492	500	
556	507	515	523	531	539	547	554	562	570	578	
557	586	593	601	609	617	624	632	640	648	656	
558	663	671	679	687	695	702	710	718	726	733	
559	741	749	757	764	772	780	788	796	803	811	
560	819	827	834	842	850	858	865	873	881	889	
561	896	904	912	920	927	935	943	950	958	966	8
562	974	981	989	997	*005	*012	*020	*028	*035	*043	1 0.8
563	75 051	059	066	074	082	089	097	105	113	120	2 1.6
564	128	136	143	151	159	166	174	182	189	197	3 2.4
565	205	213	220	228	236	243	251	259	266	274	4 3.2
566	282	289	297	305	312	320	328	335	343	351	5 4.0
567	358	366	374	381	389	397	404	412	420	427	6 4.8
568	435	442	450	458	465	473	481	488	496	504	7 5.6
569	511	519	526	534	542	549	557	565	572	580	8 6.4
570	587	595	603	610	618	626	633	641	648	656	9 7.2
571	664	671	679	686	694	702	709	717	724	732	
572	740	747	755	762	770	778	785	793	800	808	
573	815	823	831	838	846	853	861	868	876	884	
574	891	899	906	914	921	929	937	944	952	959	
575	967	974	982	989	997	*005	*012	*020	*027	*035	
576	76 042	050	057	065	072	080	087	095	103	110	
577	118	125	133	140	148	155	163	170	178	185	
578	193	200	208	215	223	230	238	245	253	260	
579	268	275	283	290	298	305	313	320	328	335	
580	343	350	358	365	373	380	388	395	403	410	
581	418	425	433	440	448	455	462	470	477	485	7
582	492	500	507	515	522	530	537	545	552	559	1 0.7
583	567	574	582	589	597	604	612	619	626	634	2 1.4
584	641	649	656	664	671	678	686	693	701	708	3 2.1
585	716	723	730	738	745	753	760	768	775	782	4 2.8
586	790	797	805	812	819	827	834	842	849	856	5 3.5
587	864	871	879	886	893	901	908	916	923	930	6 4.2
588	938	945	953	960	967	975	982	989	997	*004	7 4.9
589	77 012	019	026	034	041	048	056	063	070	078	8 5.6
590	085	093	100	107	115	122	129	137	144	151	9 6.3
591	159	166	173	181	188	195	203	210	217	225	
592	232	240	247	254	262	269	276	283	291	298	
593	305	313	320	327	335	342	349	357	364	371	
594	379	386	393	401	408	415	422	430	437	444	
595	452	459	466	474	481	488	495	503	510	517	
596	525	532	539	546	554	561	568	576	583	590	
597	597	605	612	619	627	634	641	648	656	663	
598	670	677	685	692	699	706	714	721	728	735	
599	743	750	757	764	772	779	786	793	801	808	
600	815	822	830	837	844	851	859	866	873	880	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

TABLE I

600-650

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
600	77 815	822	830	837	844	851	859	866	873	880	
601	887	895	902	909	916	924	931	938	945	952	
602	960	967	974	981	988	996	*003	*010	*017	*025	
603	78 032	039	046	053	061	068	075	082	089	097	
604	104	111	118	125	132	140	147	154	161	168	
605	176	183	190	197	204	211	219	226	233	240	
606	247	254	262	269	276	283	290	297	305	312	
607	319	326	333	340	347	355	362	369	376	383	8
608	390	398	405	412	419	426	433	440	447	455	1 0.8
609	462	469	476	483	490	497	504	512	519	526	2 1.6
610	533	540	547	554	561	569	576	583	590	597	3 2.4
611	604	611	618	625	633	640	647	654	661	668	4 3.2
612	675	682	689	696	704	711	718	725	732	739	5 4.0
613	746	753	760	767	774	781	789	796	803	810	6 4.8
614	817	824	831	838	845	852	859	866	873	880	7 5.6
615	888	895	902	909	916	923	930	937	944	951	8 6.4
616	958	965	972	979	986	993	*000	*007	*014	*021	9 7.2
617	79 029	036	043	050	057	064	071	078	085	092	
618	099	106	113	120	127	134	141	148	155	162	
619	169	176	183	190	197	204	211	218	225	232	
620	239	246	253	260	267	274	281	288	295	302	
621	309	316	323	330	337	344	351	358	365	372	
622	379	386	393	400	407	414	421	428	435	442	7
623	449	456	463	470	477	484	491	498	505	511	1 0.7
624	518	525	532	539	546	553	560	567	574	581	2 1.4
625	588	595	602	609	616	623	630	637	644	650	3 2.1
626	657	664	671	678	685	692	699	706	713	720	4 2.8
627	727	734	741	748	754	761	768	775	782	789	5 3.5
628	796	803	810	817	824	831	837	844	851	858	6 4.2
629	865	872	879	886	893	900	906	913	920	927	7 4.9
630	934	941	948	955	962	969	975	982	989	996	8 5.6
631	80 003	010	017	024	030	037	044	051	058	065	9 6.3
632	072	079	085	092	099	106	113	120	127	134	
633	140	147	154	161	168	175	182	188	195	202	
634	209	216	223	229	236	243	250	257	264	271	
635	277	284	291	298	305	312	318	325	332	339	
636	346	353	359	366	373	380	387	393	400	407	
637	414	421	428	434	441	448	455	462	468	475	6
638	482	489	496	502	509	516	523	530	536	543	1 0.6
639	550	557	564	570	577	584	591	598	604	611	2 1.2
640	618	625	632	638	645	652	659	665	672	679	3 1.8
641	686	693	699	706	713	720	726	733	740	747	4 2.4
642	754	760	767	774	781	787	794	801	808	814	5 3.0
643	821	828	835	841	848	855	862	868	875	882	6 3.6
644	889	895	902	909	916	922	929	936	943	949	7 4.2
645	956	963	969	976	983	990	996	*003	*010	*017	8 4.8
646	81 023	030	037	043	050	057	064	070	077	084	9 5.4
647	090	097	104	111	117	124	131	137	144	151	
648	158	164	171	178	184	191	198	204	211	218	
649	224	231	238	245	251	258	265	271	278	285	
650	291	298	305	311	318	325	331	338	345	351	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
650	81 291	298	305	311	318	325	331	338	345	351	
651	358	365	371	378	385	391	398	405	411	418	
652	425	431	438	445	451	458	465	471	478	485	
653	491	498	505	511	518	525	531	538	544	551	
654	558	564	571	578	584	591	598	604	611	617	
655	624	631	637	644	651	657	664	671	677	684	
656	690	697	704	710	717	723	730	737	743	750	
657	757	763	770	776	783	790	796	803	809	816	
658	823	829	836	842	849	856	862	869	875	882	
659	889	895	902	908	915	921	928	935	941	948	
660	954	961	968	974	981	987	994	*000	*007	*014	
661	82 020	027	033	040	046	053	060	066	073	079	
662	086	092	099	105	112	119	125	132	138	145	
663	151	158	164	171	178	184	191	197	204	210	
664	217	223	230	236	243	249	256	263	269	276	
665	282	289	295	302	308	315	321	328	334	341	
666	347	354	360	367	373	380	387	393	400	406	
667	413	419	426	432	439	445	452	458	465	471	
668	478	484	491	497	504	510	517	523	530	536	
669	543	549	556	562	569	575	582	588	595	601	
670	607	614	620	627	633	640	646	653	659	666	
671	672	679	685	692	698	705	711	718	724	730	
672	737	743	750	756	763	769	776	782	789	795	
673	802	808	814	821	827	834	840	847	853	860	
674	866	872	879	885	892	898	905	911	918	924	
675	930	937	943	950	956	963	969	975	982	988	
676	995	*001	*008	*014	*020	*027	*033	*040	*046	*052	
677	83 059	065	072	078	085	091	097	104	110	117	
678	123	129	136	142	149	155	161	168	174	181	
679	187	193	200	206	213	219	225	232	238	245	
680	251	257	264	270	276	283	289	296	302	308	
681	315	321	327	334	340	347	353	359	366	372	
682	378	385	391	398	404	410	417	423	429	436	
683	442	448	455	461	467	474	480	487	493	499	
684	506	512	518	525	531	537	544	550	556	563	
685	569	575	582	588	594	601	607	613	620	626	
686	632	639	645	651	658	664	670	677	683	689	
687	696	702	708	715	721	727	734	740	746	753	
688	759	765	771	778	784	790	797	803	809	816	
689	822	828	835	841	847	853	860	866	872	879	
690	885	891	897	904	910	916	923	929	935	942	
691	948	954	960	967	973	979	985	992	998	*004	
692	84 011	017	023	029	036	042	048	055	061	067	
693	073	080	086	092	098	105	111	117	123	130	
694	136	142	148	155	161	167	173	180	186	192	
695	198	205	211	217	223	230	236	242	248	255	
696	261	267	273	280	286	292	298	305	311	317	
697	323	330	336	342	348	354	361	367	373	379	
698	386	392	398	404	410	417	423	429	435	442	
699	448	454	460	466	473	479	485	491	497	504	
700	510	516	522	528	535	541	547	553	559	566	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

7	
1	0.7
2	1.4
3	2.1
4	2.8
5	3.5
6	4.2
7	4.9
8	5.6
9	6.3

6	
1	0.6
2	1.2
3	1.8
4	2.4
5	3.0
6	3.6
7	4.2
8	4.8
9	5.4

TABLE I

700-750

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
700	84 510	516	522	528	535	541	547	553	559	566	
701	572	578	584	590	597	603	609	615	621	628	
702	634	640	646	652	658	665	671	677	683	689	
703	696	702	708	714	720	726	733	739	745	751	
704	757	763	770	776	782	788	794	800	807	813	
705	819	825	831	837	844	850	856	862	868	874	
706	880	887	893	899	905	911	917	924	930	936	**7**
707	942	948	954	960	967	973	979	985	991	997	1 0.7
708	85 003	009	016	022	028	034	040	046	052	058	2 1.4
709	065	071	077	083	089	095	101	107	114	120	3 2.1
710	126	132	138	144	150	156	163	169	175	181	4 2.8
711	187	193	199	205	211	217	224	230	236	242	5 3.5
712	248	254	260	266	272	278	285	291	297	303	6 4.2
713	309	315	321	327	333	339	345	352	358	364	7 4.9
714	370	376	382	388	394	400	406	412	418	425	8 5.6
715	431	437	443	449	455	461	467	473	479	485	9 6.3
716	491	497	503	509	516	522	528	534	540	546	
717	552	558	564	570	576	582	588	594	600	606	
718	612	618	625	631	637	643	649	655	661	667	
719	673	679	685	691	697	703	709	715	721	727	
720	733	739	745	751	757	763	769	775	781	788	
721	794	800	806	812	818	824	830	836	842	848	**6**
722	854	860	866	872	878	884	890	896	902	908	1 0.6
723	914	920	926	932	938	944	950	956	962	968	2 1.2
724	974	980	986	992	998	*004	*010	*016	*022	*028	3 1.8
725	86 034	040	046	052	058	064	070	076	082	088	4 2.4
726	094	100	106	112	118	124	130	136	141	147	5 3.0
727	153	159	165	171	177	183	189	195	201	207	6 3.6
728	213	219	225	231	237	243	249	255	261	267	7 4.2
729	273	279	285	291	297	303	308	314	320	326	8 4.8
730	332	338	344	350	356	362	368	374	380	386	9 5.4
731	392	398	404	410	415	421	427	433	439	445	
732	451	457	463	469	475	481	487	493	499	504	
733	510	516	522	528	534	540	546	552	558	564	
734	570	576	581	587	593	599	605	611	617	623	
735	629	635	641	646	652	658	664	670	676	682	
736	688	694	700	705	711	717	723	729	735	741	**5**
737	747	753	759	764	770	776	782	788	794	800	1 0.5
738	806	812	817	823	829	835	841	847	853	859	2 1.0
739	864	870	876	882	888	894	900	906	911	917	3 1.5
740	923	929	935	941	947	953	958	964	970	976	4 2.0
741	982	988	994	999	*005	*011	*017	*023	*029	*035	5 2.5
742	87 040	046	052	058	064	070	075	081	087	093	6 3.0
743	099	105	111	116	122	128	134	140	146	151	7 3.5
744	157	163	169	175	181	186	192	198	204	210	8 4.0
745	216	221	227	233	239	245	251	256	262	268	9 4.5
746	274	280	286	291	297	303	309	315	320	326	
747	332	338	344	349	355	361	367	373	379	384	
748	390	396	402	408	413	419	425	431	437	442	
749	448	454	460	466	471	477	483	489	495	500	
750	506	512	518	523	529	535	541	547	552	558	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
750	87 506	512	518	523	529	535	541	547	552	558	
751	564	570	576	581	587	593	599	604	610	616	
752	622	628	633	639	645	651	656	662	668	674	
753	679	685	691	697	703	708	714	720	726	731	
754	737	743	749	754	760	766	772	777	783	789	
755	795	800	806	812	818	823	829	835	841	846	
756	852	858	864	869	875	881	887	892	898	904	
757	910	915	921	927	933	938	944	950	955	961	
758	967	973	978	984	990	996	*001	*007	*013	*018	
759	88 024	030	036	041	047	053	058	064	070	076	
760	081	087	093	098	104	110	116	121	127	133	
761	138	144	150	156	161	167	173	178	184	190	
762	195	201	207	213	218	224	230	235	241	247	6
763	252	258	264	270	275	281	287	292	298	304	1 0.6
764	309	315	321	326	332	338	343	349	355	360	2 1.2
765	366	372	377	383	389	395	400	406	412	417	3 1.8
766	423	429	434	440	446	451	457	463	468	474	4 2.4
767	480	485	491	497	502	508	513	519	525	530	5 3.0
768	536	542	547	553	559	564	570	576	581	587	6 3.6
769	593	598	604	610	615	621	627	632	638	643	7 4.2
770	649	655	660	666	672	677	683	689	694	700	8 4.8
771	705	711	717	722	728	734	739	745	750	756	9 5.4
772	762	767	773	779	784	790	795	801	807	812	
773	818	824	829	835	840	846	852	857	863	868	
774	874	880	885	891	897	902	908	913	919	925	
775	930	936	941	947	953	958	964	969	975	981	
776	986	992	997	*003	*009	*014	*020	*025	*031	*037	
777	89 042	048	053	059	064	070	076	081	087	092	
778	098	104	109	115	120	126	131	137	143	148	
779	154	159	165	170	176	182	187	193	198	204	
780	209	215	221	226	232	237	243	248	254	260	
781	265	271	276	282	287	293	298	304	310	315	5
782	321	326	332	337	343	348	354	360	365	371	1 0.5
783	376	382	387	393	398	404	409	415	421	426	2 1.0
784	432	437	443	448	454	459	465	470	476	481	3 1.5
785	487	492	498	504	509	515	520	526	531	537	4 2.0
786	542	548	553	559	564	570	575	581	586	592	5 2.5
787	597	603	609	614	620	625	631	636	642	647	6 3.0
788	653	658	664	669	675	680	686	691	697	702	7 3.5
789	708	713	719	724	730	735	741	746	752	757	8 4.0
790	763	768	774	779	785	790	796	801	807	812	9 4.5
791	818	823	829	834	840	845	851	856	862	867	
792	873	878	883	889	894	900	905	911	916	922	
793	927	933	938	944	949	955	960	966	971	977	
794	982	988	993	998	*004	*009	*015	*020	*026	*031	
795	90 037	042	048	053	059	064	069	075	080	086	
796	091	097	102	108	113	119	124	129	135	140	
797	146	151	157	162	168	173	179	184	189	195	
798	200	206	211	217	222	227	233	238	244	249	
799	255	260	266	271	276	282	287	293	298	304	
800	309	314	320	325	331	336	342	347	352	358	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

TABLE I **800-850**

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
800	90 309	314	320	325	331	336	342	347	352	358	
801	363	369	374	380	385	390	396	401	407	412	
802	417	423	428	434	439	445	450	455	461	466	
803	472	477	482	488	493	499	504	509	515	520	
804	526	531	536	542	547	553	558	563	569	574	
805	580	585	590	596	601	607	612	617	623	628	
806	634	639	644	650	655	660	666	671	677	682	
807	687	693	698	703	709	714	720	725	730	736	
808	741	747	752	757	763	768	773	779	784	789	
809	795	800	806	811	816	822	827	832	838	843	
810	849	854	859	865	870	875	881	886	891	897	
811	902	907	913	918	924	929	934	940	945	950	6
812	956	961	966	972	977	982	988	993	998	*004	1 0.6
813	91 009	014	020	025	030	036	041	046	052	057	2 1.2
814	062	068	073	078	084	089	094	100	105	110	3 1.8
815	116	121	126	132	137	142	148	153	158	164	4 2.4
816	169	174	180	185	190	196	201	206	212	217	5 3.0
817	222	228	233	238	243	249	254	259	265	270	6 3.6
818	275	281	286	291	297	302	307	312	318	323	7 4.2
819	328	334	339	344	350	355	360	365	371	376	8 4.8
820	381	387	392	397	403	408	413	418	424	429	9 5.4
821	434	440	445	450	455	461	466	471	477	482	
822	487	492	498	503	508	514	519	524	529	535	
823	540	545	551	556	561	566	572	577	582	587	
824	593	598	603	609	614	619	624	630	635	640	
825	645	651	656	661	666	672	677	682	687	693	
826	698	703	709	714	719	724	730	735	740	745	
827	751	756	761	766	772	777	782	787	793	798	
828	803	808	814	819	824	829	834	840	845	850	
829	855	861	866	871	876	882	887	892	897	903	
830	908	913	918	924	929	934	939	944	950	955	
831	960	965	971	976	981	986	991	997	*002	*007	5
832	92 012	018	023	028	033	038	044	049	054	059	1 0.5
833	065	070	075	080	085	091	096	101	106	111	2 1.0
834	117	122	127	132	137	143	148	153	158	163	3 1.5
835	169	174	179	184	189	195	200	205	210	215	4 2.0
836	221	226	231	236	241	247	252	257	262	267	5 2.5
837	273	278	283	288	293	298	304	309	314	319	6 3.0
838	324	330	335	340	345	350	355	361	366	371	7 3.5
839	376	381	387	392	397	402	407	412	418	423	8 4.0
840	428	433	438	443	449	454	459	464	469	474	9 4.5
841	480	485	490	495	500	505	511	516	521	526	
842	531	536	542	547	552	557	562	567	572	578	
843	583	588	593	598	603	609	614	619	624	629	
844	634	639	645	650	655	660	665	670	675	681	
845	686	691	696	701	706	711	716	722	727	732	
846	737	742	747	752	758	763	768	773	778	783	
847	788	793	799	804	809	814	819	824	829	834	
848	840	845	850	855	860	865	870	875	881	886	
849	891	896	901	906	911	916	921	927	932	937	
850	942	947	952	957	962	967	973	978	983	988	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
850	92 942	947	952	957	962	967	973	978	983	988	
851	993	998	*003	*008	*013	*018	*024	*029	*034	*039	
852	93 044	049	054	059	064	069	075	080	085	090	
853	095	100	105	110	115	120	125	131	136	141	
854	146	151	156	161	166	171	176	181	186	192	
855	197	202	207	212	217	222	227	232	237	242	
856	247	252	258	263	268	273	278	283	288	293	
857	298	303	308	313	318	323	328	334	339	344	6
858	349	354	359	364	369	374	379	384	389	394	1 0.6
859	399	404	409	414	420	425	430	435	440	445	2 1.2
860	450	455	460	465	470	475	480	485	490	495	3 1.8
861	500	505	510	515	520	526	531	536	541	546	4 2.4
862	551	556	561	566	571	576	581	586	591	596	5 3.0
863	601	606	611	616	621	626	631	636	641	646	6 3.6
864	651	656	661	666	671	676	682	687	692	697	7 4.2
865	702	707	712	717	722	727	732	737	742	747	8 4.8
866	752	757	762	767	772	777	782	787	792	797	9 5.4
867	802	807	812	817	822	827	832	837	842	847	
868	852	857	862	867	872	877	882	887	892	897	
869	902	907	912	917	922	927	932	937	942	947	
870	952	957	962	967	972	977	982	987	992	997	
871	94 002	007	012	017	022	027	032	037	042	047	
872	052	057	062	067	072	077	082	086	091	096	5
873	101	106	111	116	121	126	131	136	141	146	1 0.5
874	151	156	161	166	171	176	181	186	191	196	2 1.0
875	201	206	211	216	221	226	231	236	240	245	3 1.5
876	250	255	260	265	270	275	280	285	290	295	4 2.0
877	300	305	310	315	320	325	330	335	340	345	5 2.5
878	349	354	359	364	369	374	379	384	389	394	6 3.0
879	399	404	409	414	419	424	429	433	438	443	7 3.5
880	448	453	458	463	468	473	478	483	488	493	8 4.0
881	498	503	507	512	517	522	527	532	537	542	9 4.5
882	547	552	557	562	567	571	576	581	586	591	
883	596	601	606	611	616	621	626	630	635	640	
884	645	650	655	660	665	670	675	680	685	689	
885	694	699	704	709	714	719	724	729	734	738	
886	743	748	753	758	763	768	773	778	783	787	
887	792	797	802	807	812	817	822	827	832	836	4
888	841	846	851	856	861	866	871	876	880	885	1 0.4
889	890	895	900	905	910	915	919	924	929	934	2 0.8
890	939	944	949	954	959	963	968	973	978	983	3 1.2
891	988	993	998	*002	*007	*012	*017	*022	*027	*032	4 1.6
892	95 036	041	046	051	056	061	066	071	075	080	5 2.0
893	085	090	095	100	105	109	114	119	124	129	6 2.4
894	134	139	143	148	153	158	163	168	173	177	7 2.8
895	182	187	192	197	202	207	211	216	221	226	8 3.2
896	231	236	240	245	250	255	260	265	270	274	9 3.6
897	279	284	289	294	299	303	308	313	318	323	
898	328	332	337	342	347	352	357	361	366	371	
899	376	381	386	390	395	400	405	410	415	419	
900	424	429	434	439	444	448	453	458	463	468	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

TABLE I

900-950

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
900	95 424	429	434	439	444	448	453	458	463	468	
901	472	477	482	487	492	497	501	506	511	516	
902	521	525	530	535	540	545	550	554	559	564	
903	569	574	578	583	588	593	598	602	607	612	
904	617	622	626	631	636	641	646	650	655	660	
905	665	670	674	679	684	689	694	698	703	708	
906	713	718	722	727	732	737	742	746	751	756	
907	761	766	770	775	780	785	789	794	799	804	
908	809	813	818	823	828	832	837	842	847	852	
909	856	861	866	871	875	880	885	890	895	899	
910	904	909	914	918	923	928	933	938	942	947	
911	952	957	961	966	971	976	980	985	990	995	5 | 0.5
912	999	*004	*009	*014	*019	*023	*028	*033	*038	*042	1 | 1.0
913	96 047	052	057	061	066	071	076	080	085	090	2 | 1.5
914	095	099	104	109	114	118	123	128	133	137	3 | 2.0
915	142	147	152	156	161	166	171	175	180	185	4 | 2.5
916	190	194	199	204	209	213	218	223	227	232	5 | 3.0
917	237	242	246	251	256	261	265	270	275	280	6 | 3.5
918	284	289	294	298	303	308	313	317	322	327	7 | 4.0
919	332	336	341	346	350	355	360	365	369	374	8 | 4.5
920	379	384	388	393	398	402	407	412	417	421	9 | 4.5
921	426	431	435	440	445	450	454	459	464	468	
922	473	478	483	487	492	497	501	506	511	515	
923	520	525	530	534	539	544	548	553	558	562	
924	567	572	577	581	586	591	595	600	605	609	
925	614	619	624	628	633	638	642	647	652	656	
926	661	666	670	675	680	685	689	694	699	703	
927	708	713	717	722	727	731	736	741	745	750	
928	755	759	764	769	774	778	783	788	792	797	
929	802	806	811	816	820	825	830	834	839	844	
930	848	853	858	862	867	872	876	881	886	890	
931	895	900	904	909	914	918	923	928	932	937	4 | 0.4
932	942	946	951	956	960	965	970	974	979	984	1 | 0.8
933	988	993	997	*002	*007	*011	*016	*021	*025	*030	2 | 1.2
934	97 035	039	044	049	053	058	063	067	072	077	3 | 1.6
935	081	086	090	095	100	104	109	114	118	123	4 | 2.0
936	128	132	137	142	146	151	155	160	165	169	5 | 2.4
937	174	179	183	188	192	197	202	206	211	216	6 | 2.8
938	220	225	230	234	239	243	248	253	257	262	7 | 3.2
939	267	271	276	280	285	290	294	299	304	308	8 | 3.6
940	313	317	322	327	331	336	340	345	350	354	9 | 3.6
941	359	364	368	373	377	382	387	391	396	400	
942	405	410	414	419	424	428	433	437	442	447	
943	451	456	460	465	470	474	479	483	488	498	
944	497	502	506	511	516	520	525	529	534	539	
945	543	548	552	557	562	566	571	575	580	585	
946	589	594	598	603	607	612	617	621	626	630	
947	635	640	644	649	653	658	663	667	672	676	
948	681	685	690	695	699	704	708	713	717	722	
949	727	731	736	740	745	749	754	759	763	768	
950	772	777	782	786	791	795	800	804	809	813	
N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.

N.	0	1	2	3	4	5	6	7	8	9	Prop. Pts.
950	97 772	777	782	786	791	795	800	804	809	813	
951	818	823	827	832	836	841	845	850	855	859	
952	864	868	873	877	882	886	891	896	900	905	
953	909	914	918	923	928	932	937	941	946	950	
954	955	959	964	968	973	978	982	987	991	996	
955	98 000	005	009	014	019	023	028	032	037	041	
956	046	050	055	059	064	068	073	078	082	087	
957	091	096	100	105	109	114	118	123	127	132	
958	137	141	146	150	155	159	164	168	173	177	
959	182	186	191	195	200	204	209	214	218	223	
960	227	232	236	241	245	250	254	259	263	268	
961	272	277	281	286	290	295	299	304	308	313	
962	318	322	327	331	336	340	345	349	354	358	
963	363	367	372	376	381	385	390	394	399	403	
964	408	412	417	421	426	430	435	439	444	448	
965	453	457	462	466	471	475	480	484	489	493	
966	498	502	507	511	516	520	525	529	534	538	
967	543	547	552	556	561	565	570	574	579	583	
968	588	592	597	601	605	610	614	619	623	628	
969	632	637	641	646	650	655	659	664	668	673	
970	677	682	686	691	695	700	704	709	713	717	
971	722	726	731	735	740	744	749	753	758	762	
972	767	771	776	780	784	789	793	798	802	807	
973	811	816	820	825	829	834	838	843	847	851	
974	856	860	865	869	874	878	883	887	892	896	
975	900	905	909	914	918	923	927	932	936	941	
976	945	949	954	958	963	967	972	976	981	985	
977	989	994	998	*003	*007	*012	*016	*021	*025	*029	
978	99 034	038	043	047	052	056	061	065	069	074	
979	078	083	087	092	096	100	105	109	114	118	
980	123	127	131	136	140	145	149	154	158	162	
981	167	171	176	180	185	189	193	198	202	207	
982	211	216	220	224	229	233	238	242	247	251	
983	255	260	264	269	273	277	282	286	291	295	
984	300	304	308	313	317	322	326	330	335	339	
985	344	348	352	357	361	366	370	374	379	383	
986	388	392	396	401	405	410	414	419	423	427	
987	432	436	441	445	449	454	458	463	467	471	
988	476	480	484	489	493	498	502	506	511	515	
989	520	524	528	533	537	542	546	550	555	559	
990	564	568	572	577	581	585	590	594	599	603	
991	607	612	616	621	625	629	634	638	642	647	
992	651	656	660	664	669	673	677	682	686	691	
993	695	699	704	708	712	717	721	726	730	734	
994	739	743	747	752	756	760	765	769	774	778	
995	782	787	791	795	800	804	808	813	817	822	
996	826	830	835	839	843	848	852	856	861	865	
997	870	874	878	883	887	891	896	900	904	909	
998	913	917	922	926	930	935	939	944	948	952	
999	957	961	965	970	974	978	983	987	991	996	
1000	00 000	004	009	013	017	022	026	030	035	039	
N.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Prop. Pts.**

5	
1	0.5
2	1.0
3	1.5
4	2.0
5	2.5
6	3.0
7	3.5
8	4.0
9	4.5

4	
1	0.4
2	0.8
3	1.2
4	1.6
5	2.0
6	2.4
7	2.8
8	3.2
9	3.6

Special interpolation in Table III. In the first three columns on pages **80**, **81**, and **82**, the tabular differences are so large that linear interpolation gives inaccurate results. Since every entry for the logarithm of the cosine of an angle near 90° can be thought of as the logarithm of the sine of an angle near 0°, it is sufficient if we consider only the sines of small angles. In like manner, since the tangent and cotangent are both reciprocals and cofunctions, it is sufficient to consider interpolation for tangents of very small angles, for we have

$$\log \tan A = -\log \cot A = -\log \tan (90° - A) = \log \cot (90° - A).$$

If A and B are sufficiently small angles, both expressed in minutes, it can be shown that the fol owing relations are accurate to five places of decimals.

(*a*) $\log \sin A = \log \sin B + \log A - \log B;$

(*b*) $\log \tan A = \log \tan B + \log A - \log B.$

In particular, these relations will be reliable to five places of decimals if both A and B are less than 3°, and $A - B$ is less than 1′. Since these conditions are true for interpolation problems for the sine and tangent in the first columns on pages **80**, **81**, and **82**, these formulas may be used.

Example 1. Find log cos 89° 27.5′. This is the same as finding

$$\log \sin 0° 32.5'.$$

Let $A = 32.5'$, and let $B = 32'$. Then

$$\log \sin 32.5' = \log \sin 32' + \log 32.5 - \log 32,$$

whence log cos 89° 27.5′ = 7.97560 − 10.

Example 2. Find log tan 1° 15.2′. Let $A = 1° 15.2' = 75.2'$, and let $B = 1° 15' = 75'$. Then

$$\log \tan 1° 15.2' = \log \tan 1° 15' + \log 75.2 - \log 75 = 8.34002 - 10.$$

NOTE. Ordinary linear interpolation in the first example would have given the result 7.97555 − 10, with an error of 5 in the last place. Linear interpolation in the last example would have given the result 8.34001 − 10, with an error of 1 in the last place.

TABLE II

Logarithms of Trigonometric Functions to Five Decimal Places

(*Subtract* 10 *from Each Entry*)

′	L Sin	d	L Tan	c d	L Cot	L Cos		
0	———		———		———	0.00 000	**60**	
1	6.46 373	30103	6.46 373	30103	13.53 627	0.00 000	59	
2	6.76 476	17609	6.76 476	17609	13.23 524	0.00 000	58	
3	6.94 085	12494	6.94 085	12494	13.05 915	0.00 000	57	
4	7.06 579	9691	7.06 579	9691	12.93 421	0.00 000	56	
5	7.16 270	7918	7.16 270	7918	12.83 730	0.00 000	55	
6	7.24 188	6694	7.24 188	6694	12.75 812	0.00 000	54	
7	7.30 882	5800	7.30 882	5800	12.69 118	0.00 000	53	
8	7.36 682	5115	7.36 682	5115	12.63 318	0.00 000	52	
9	7.41 797	4576	7.41 797	4576	12.58 203	0.00 000	51	
10	7.46 373	4139	7.46 373	4139	12.53 627	0.00 000	**50**	
11	7.50 512	3779	7.50 512	3779	12.49 488	0.00 000	49	
12	7.54 291	3476	7.54 291	3476	12.45 709	0.00 000	48	
13	7.57 767	3218	7.57 767	3219	12.42 233	0.00 000	47	
14	7.60 985	2997	7.60 986	2996	12.39 014	0.00 000	46	
15	7.63 982	2802	7.63 982	2803	12.36 018	0.00 000	45	
16	7.66 784	2633	7.66 785	2633	12.33 215	0.00 000	44	
17	7.69 417	2483	7.69 418	2482	12.30 582	9.99 999	43	
18	7.71 900	2348	7.71 900	2348	12.28 100	9.99 999	42	
19	7.74 248	2227	7.74 248	2228	12.25 752	9.99 999	41	
20	7.76 475	2119	7.76 476	2119	12.23 524	9.99 999	**40**	
21	7.78 594	2021	7.78 595	2020	12.21 405	9.99 999	39	
22	7.80 615	1930	7.80 615	1931	12.19 385	9.99 999	38	
23	7.82 545	1848	7.82 546	1848	12.17 454	9.99 999	37	
24	7.84 393	1773	7.84 394	1773	12.15 606	9.99 999	36	
25	7.86 166	1704	7.86 167	1704	12.13 833	9.99 999	35	
26	7.87 870	1639	7.87 871	1639	12.12 129	9.99 999	34	
27	7.89 509	1579	7.89 510	1579	12.10 490	9.99 999	33	
28	7.91 088	1524	7.91 089	1524	12.08 911	9.99 999	32	
29	7.92 612	1472	7.92 613	1473	12.07 387	9.99 998	31	
30	7.94 084	1424	7.94 086	1424	12.05 914	9.99 998	**30**	
31	7.95 508	1379	7.95 510	1379	12.04 490	9.99 998	29	
32	7.96 887	1336	7.96 889	1336	12.03 111	9.99 998	28	
33	7.98 223	1297	7.98 225	1297	12.01 775	9.99 998	27	
34	7.99 520	1259	7.99 522	1259	12.00 478	9.99 998	26	
35	8.00 779	1223	8.00 781	1223	11.99 219	9.99 998	25	
36	8.02 002	1190	8.02 004	1190	11.97 996	9.99 998	24	
37	8.03 192	1158	8.03 194	1159	11.96 806	9.99 997	23	
38	8.04 350	1128	8.04 353	1128	11.95 647	9.99 997	22	
39	8.05 478	1100	8.05 481	1100	11.94 519	9.99 997	21	
40	8.06 578	1072	8.06 581	1072	11.93 419	9.99 997	**20**	
41	8.07 650	1046	8.07 653	1047	11.92 347	9.99 997	19	
42	8.08 696	1022	8.08 700	1022	11.91 300	9.99 997	18	
43	8.09 718	999	8.09 722	998	11.90 278	9.99 997	17	
44	8.10 717	976	8.10 720	976	11.89 280	9.99 996	16	
45	8.11 693	954	8.11 696	955	11.88 304	9.99 996	15	
46	8.12 647	934	8.12 651	934	11.87 349	9.99 996	14	
47	8.13 581	914	8.13 585	915	11.86 415	9.99 996	13	
48	8.14 495	896	8.14 500	895	11.85 500	9.99 996	12	
49	8.15 391	877	8.15 395	878	11.84 605	9.99 996	11	
50	8.16 268	860	8.16 273	860	11.83 727	9.99 995	**10**	
51	8.17 128	843	8.17 133	843	11.82 867	9.99 995	9	
52	8.17 971	827	8.17 976	828	11.82 024	9.99 995	8	
53	8.18 798	812	8.18 804	812	11.81 196	9.99 995	7	
54	8.19 610	797	8.19 616	797	11.80 384	9.99 995	6	
55	8.20 407	782	8.20 413	782	11.79 587	9.99 994	5	
56	8.21 189	769	8.21 195	769	11.78 805	9.99 994	4	
57	8.21 958	755	8.21 964	756	11.78 036	9.99 994	3	
58	8.22 713	743	8.22 720	742	11.77 280	9.99 994	2	
59	8.23 456	730	8.23 462	730	11.76 538	9.99 994	1	
60	8.24 186		8.24 192		11.75 808	9.99 993	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	

Since the tabular differences in the first three columns of this page, and on each of the two pages following, are so large and change so rapidly in value that ordinary linear interpolation does not give results accurate to five places of decimals, special methods of interpolation are necessary. A brief account of these special methods is given on page 26 of the tables.

89°

′	L Sin	d	L Tan	c d	L Cot	L Cos		
0	8.24 186	717	8.24 192	718	11.75 808	9.99 993	**60**	If ordinary linear interpolation is not sufficiently accurate, use the special methods described on page 26 of the tables.
1	8.24 903	706	8.24 910	706	11.75 090	9.99 993	59	
2	8.25 609	695	8.25 616	696	11.74 384	9.99 993	58	
3	8.26 304	684	8.26 312	684	11.73 688	9.99 993	57	
4	8.26 988	673	8.26 996	673	11.73 004	9.99 992	56	
5	8.27 661	663	8.27 669	663	11.72 331	9.99 992	55	
6	8.28 324	653	8.28 332	654	11.71 668	9.99 992	54	
7	8.28 977	644	8.28 986	643	11.71 014	9.99 992	53	
8	8.29 621	634	8.29 629	634	11.70 371	9.99 992	52	
9	8.30 255	624	8.30 263	625	11.69 737	9.99 991	51	
10	8.30 879	616	8.30 888	617	11.69 112	9.99 991	**50**	
11	8.31 495	608	8.31 505	607	11.68 495	9.99 991	49	
12	8.32 103	599	8.32 112	599	11.67 888	9.99 990	48	
13	8.32 702	590	8.32 711	591	11.67 289	9.99 990	47	
14	8.33 292	583	8.33 302	584	11.66 698	9.99 990	46	
15	8.33 875	575	8.33 886	575	11.66 114	9.99 990	45	
16	8.34 450	568	8.34 461	568	11.65 539	9.99 989	44	
17	8.35 018	560	8.35 029	561	11.64 971	9.99 989	43	
18	8.35 578	553	8.35 590	553	11.64 410	9.99 989	42	
19	8.36 131	547	8.36 143	546	11.63 857	9.99 989	41	
20	8.36 678	539	8.36 689	540	11.63 311	9.99 988	**40**	
21	8.37 217	533	8.37 229	533	11.62 771	9.99 988	39	
22	8.37 750	526	8.37 762	527	11.62 238	9.99 988	38	
23	8.83 276	520	8.38 289	520	11.61 711	9.99 987	37	
24	8.38 796	514	8.38 809	514	11.61 191	9.99 987	36	
25	8.39 310	508	8.39 323	509	11.60 677	9.99 987	35	
26	8.39 818	502	8.39 832	502	11.60 168	9.99 986	34	
27	8.40 320	496	8.40 334	496	11.59 666	9.99 986	33	
28	8.40 816	491	8.40 830	491	11.59 170	9.99 986	32	
29	8.41 307	485	8.41 321	486	11.58 679	9.99 985	31	
30	8.41 792	480	8.41 807	480	11.58 193	9.99 985	**30**	
31	8.42 272	474	8.42 287	475	11.57 713	9.99 985	29	
32	8.42 746	470	8.42 762	470	11.57 238	9.99 984	28	
33	8.43 216	464	8.43 232	464	11.56 768	9.99 984	27	
34	8.43 680	459	8.43 696	460	11.56 304	9.99 984	26	
35	8.44 139	455	8.44 156	455	11.55 844	9.99 983	25	
36	8.44 594	450	8.44 611	450	11.55 389	9.99 983	24	
37	8.45 044	445	8.45 061	446	11.54 939	9.99 983	23	
38	8.45 489	441	8.45 507	441	11.54 493	9.99 982	22	
39	8.45 930	436	8.45 948	437	11.54 052	9.99 982	21	
40	8.46 366	433	8.46 385	432	11.53 615	9.99 982	**20**	
41	8.46 799	427	8.46 817	428	11.53 183	9.99 981	19	
42	8.47 226	424	8.47 245	424	11.52 755	9.99 981	18	
43	8.47 650	419	8.47 669	420	11.52 331	9.99 981	17	
44	8.48 069	416	8.48 089	416	11.51 911	9.99 980	16	
45	8.48 485	411	8.48 505	412	11.51 495	9.99 980	15	
46	8.48 896	408	8.48 917	408	11.51 083	9.99 979	14	
47	8.49 304	404	8.49 325	404	11.50 675	9.99 979	13	
48	8.49 708	400	8.49 729	401	11.50 271	9.99 979	12	
49	8.50 108	396	8.50 130	397	11.49 870	9.99 978	11	
50	8.50 504	393	8.50 527	393	11.49 473	9.99 978	**10**	
51	8.50 897	390	8.50 920	390	11.49 080	9.99 977	9	
52	8.51 287	386	8.51 310	386	11.48 690	9.99 977	8	
53	8.51 673	382	8.51 696	383	11.48 304	9.99 977	7	
54	8.52 055	379	8.52 079	380	11.47 921	9.99 976	6	
55	8.52 434	376	8.52 459	376	11.47 541	9.99 976	5	
56	8.52 810	373	8.52 835	373	11.47 165	9.99 975	4	
57	8.53 183	369	8.53 208	370	11.46 792	9.99 975	3	
58	8.53 552	367	8.53 578	367	11.46 422	9.99 974	2	
59	8.53 919	363	8.53 945	363	11.46 055	9.99 974	1	
60	8.54 282		8.54 308		11.45 692	9.99 974	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	

TABLE II

2°

′	L Sin	d	L Tan	c d	L Cot	L Cos		
0	8.54 282	360	8.54 308	361	11.45 692	9.99 974	**60**	If ordinary linear interpolation is not sufficiently accurate, use the special methods described on page 78 of the tables.
1	8.54 642	357	8.54 669	358	11.45 331	9.99 973	59	
2	8.54 999	355	8.55 027	355	11.44 973	9.99 973	58	
3	8.55 354	351	8.55 382	352	11.44 618	9.99 972	57	
4	8.55 705	349	8.55 734	349	11.44 266	9.99 972	56	
5	8.56 054	346	8.56 083	346	11.43 917	9.99 971	55	
6	8.56 400	343	8.56 429	344	11.43 571	9.99 971	54	
7	8.56 743	341	8.56 773	341	11.43 227	9.99 970	53	
8	8.57 084	337	8.57 114	338	11.42 886	9.99 970	52	
9	8.57 421	336	8.57 452	336	11.42 548	9.99 969	51	
10	8.57 757	332	8.57 788	333	11.42 212	9.99 969	**50**	
11	8.58 089	330	8.58 121	330	11.41 879	9.99 968	49	
12	8.58 419	328	8.58 451	328	11.41 549	9.99 968	48	
13	8.58 747	325	8.58 779	326	11.41 221	9.99 967	47	
14	8.59 072	323	8.59 105	323	11.40 895	9.99 967	46	
15	8.59 395	320	8.59 428	321	11.40 572	9.99 967	45	
16	8.59 715	318	8.59 749	319	11.40 251	9.99 966	44	
17	8.60 033	316	8.60 068	316	11.39 932	9.99 966	43	
18	8.60 349	313	8.60 384	314	11.39 616	9.99 965	42	
19	8.60 662	311	8.60 698	311	11.39 302	9.99 964	41	
20	8.60 973	309	8.61 009	310	11.38 991	9.99 964	**40**	
21	8.61 282	307	8.61 319	307	11.38 681	9.99 963	39	
22	8.61 589	305	8.61 626	305	11.38 374	9.99 963	38	
23	8.61 894	302	8.61 931	303	11.38 069	9.99 962	37	
24	8.62 196	301	8.62 234	301	11.37 766	9.99 962	36	
25	8.62 497	298	8.62 535	299	11.37 465	9.99 961	35	
26	8.62 795	296	8.62 834	297	11.37 166	9.99 961	34	
27	8.63 091	294	8.63 131	295	11.36 869	9.99 960	33	
28	8.63 385	293	8.63 426	292	11.36 574	9.99 960	32	
29	8.63 678	290	8.63 718	291	11.36 282	9.99 959	31	
30	8.63 968	288	8.64 009	289	11.35 991	9.99 959	**30**	
31	8.64 256	287	8.64 298	287	11.35 702	9.99 958	29	
32	8.64 543	284	8.64 585	285	11.35 415	9.99 958	28	
33	8.64 827	283	8.64 870	284	11.35 130	9.99 957	27	
34	8.65 110	281	8.65 154	281	11.34 846	9.99 956	26	
35	8.65 391	279	8.65 435	280	11.34 565	9.99 956	25	
36	8.65 670	277	8.65 715	278	11.34 285	9.99 955	24	
37	8.65 947	276	8.65 993	276	11.34 007	9.99 955	23	
38	8.66 223	274	8.66 269	274	11.33 731	9.99 954	22	
39	8.66 497	272	8.66 543	273	11.33 457	9.99 954	21	
40	8.66 769	270	8.66 816	271	11.33 184	9.99 953	**20**	
41	8.67 039	269	8.67 087	269	11.32 913	9.99 952	19	
42	8.67 308	267	8.67 356	268	11.32 644	9.99 952	18	
43	8.67 575	266	8.67 624	266	11.32 376	9.99 951	17	
44	8.67 841	263	8.67 890	264	11.32 110	9.99 951	16	
45	8.68 104	263	8.68 154	263	11.31 846	9.99 950	15	
46	8.68 367	260	8.68 417	261	11.31 583	9.99 949	14	
47	8.68 627	259	8.68 678	260	11.31 322	9.99 949	13	
48	8.68 886	258	8.68 938	258	11.31 062	9.99 948	12	
49	8.69 144	256	8.69 196	257	11.30 804	9.99 948	11	
50	8.69 400	254	8.69 453	255	11.30 547	9.99 947	**10**	
51	8.69 654	253	8.69 708	254	11.30 292	9.99 946	9	
52	8.69 907	252	8.69 962	252	11.30 038	9.99 946	8	
53	8.70 159	250	8.70 214	251	11.29 786	9.99 945	7	
54	8.70 409	249	8.70 465	249	11.29 535	9.99 944	6	
55	8.70 658	247	8.70 714	248	11.29 286	9.99 944	5	
56	8.70 905	246	8.70 962	246	11.29 038	9.99 943	4	
57	8.71 151	244	8.71 208	245	11.28 792	9.99 942	3	
58	8.71 395	243	8.71 453	244	11.28 547	9.99 942	2	
59	8.71 638	242	8.71 697	243	11.28 303	9.99 941	1	
60	8.71 880		8.71 940		11.28 060	9.99 940	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	

87°

′	L Sin	d	L Tan	c d	L Cot	L Cos	
0	8.71 880	240	8.71 940	241	11.28 060	9.99 940	60
1	8.72 120	239	8.72 181	239	11.27 819	9.99 940	59
2	8.72 359	238	8.72 420	239	11.27 580	9.99 939	58
3	8.72 597	237	8.72 659	237	11.27 341	9.99 938	57
4	8.72 834	235	8.72 896	236	11.27 104	9.99 938	56
5	8.73 069	234	8.73 132	234	11.26 868	9.99 937	55
6	8.73 303	232	8.73 366	234	11.26 634	9.99 936	54
7	8.73 535	232	8.73 600	232	11.26 400	9.99 936	53
8	8.73 767	230	8.73 832	231	11.26 168	9.99 935	52
9	8.73 997	229	8.74 063	229	11.25 937	9.99 934	51
10	8.74 226	228	8.74 292	229	11.25 708	9.99 934	50
11	8.74 454	226	8.74 521	227	11.25 479	9.99 933	49
12	8.74 680	226	8.74 748	226	11.25 252	9.99 932	48
13	8.74 906	224	8.74 974	225	11.25 026	9.99 932	47
14	8.75 130	223	8.75 199	224	11.24 801	9.99 931	46
15	8.75 353	222	8.75 423	222	11.24 577	9.99 930	45
16	8.75 575	220	8.75 645	222	11.24 355	9.99 929	44
17	8.75 795	220	8.75 867	220	11.24 133	9.99 929	43
18	8.76 015	219	8.76 087	219	11.23 913	9.99 928	42
19	8.76 234	217	8.76 306	219	11.23 694	9.99 927	41
20	8.76 451	216	8.76 525	217	11.23 475	9.99 926	40
21	8.76 667	216	8.76 742	216	11.23 258	9.99 926	39
22	8.76 883	214	8.76 958	215	11.23 042	9.99 925	38
23	8.77 097	213	8.77 173	214	11.22 827	9.99 924	37
24	8.77 310	212	8.77 387	213	11.22 613	9.99 923	36
25	8.77 522	211	8.77 600	211	11.22 400	9.99 923	35
26	8.77 733	210	8.77 811	211	11.22 189	9.99 922	34
27	8.77 943	209	8.78 022	210	11.21 978	9.99 921	33
28	8.78 152	208	8.78 232	209	11.21 768	9.99 920	32
29	8.78 360	208	8.78 441	208	11.21 559	9.99 920	31
30	8.78 568	206	8.78 649	206	11.21 351	9.99 919	30
31	8.78 774	205	8.78 855	206	11.21 145	9.99 918	29
32	8.78 979	204	8.79 061	205	11.20 939	9.99 917	28
33	8.79 183	203	8.79 266	204	11.20 734	9.99 917	27
34	8.79 386	202	8.79 470	203	11.20 530	9.99 916	26
35	8.79 588	201	8.79 673	202	11.20 327	9.99 915	25
36	8.79 789	201	8.79 875	201	11.20 125	9.99 914	24
37	8.79 990	199	8.80 076	201	11.19 924	9.99 913	23
38	8.80 189	199	8.80 277	199	11.19 723	9.99 913	22
39	8.80 388	197	8.80 476	198	11.19 524	9.99 912	21
40	8.80 585	197	8.80 674	198	11.19 326	9.99 911	20
41	8.80 782	196	8.80 872	196	11.19 128	9.99 910	19
42	8.80 978	195	8.81 068	196	11.18 932	9.99 909	18
43	8.81 173	194	8.81 264	195	11.18 736	9.99 909	17
44	8.81 367	193	8.81 459	194	11.18 541	9.99 908	16
45	8.81 560	192	8.81 653	193	11.18 347	9.99 907	15
46	8.81 752	192	8.81 846	192	11.18 154	9.99 906	14
47	8.81 944	190	8.82 038	192	11.17 962	9.99 905	13
48	8.82 134	190	8.82 230	190	11.17 770	9.99 904	12
49	8.82 324	189	8.82 420	190	11.17 580	9.99 904	11
50	8.82 513	188	8.82 610	190	11.17 390	9.99 903	10
51	8.82 701	187	8.82 799	189	11.17 201	9.99 902	9
52	8.82 888	187	8.82 987	188	11.17 013	9.99 901	8
53	8.83 075	186	8.83 175	188	11.16 825	9.99 900	7
54	8.83 261	185	8.83 361	186	11.16 639	9.99 899	6
55	8.83 446	184	8.83 547	186	11.16 453	9.99 898	5
56	8.83 630	183	8.83 732	185	11.16 268	9.99 898	4
57	8.83 813	183	8.83 916	184	11.16 084	9.99 897	3
58	8.83 996	181	8.84 100	184	11.15 900	9.99 896	2
59	8.84 177	181	8.84 282	182	11.15 718	9.99 895	1
60	8.84 358		8.84 464	182	11.15 536	9.99 894	0
	L Cos	d	L Cot	c d	L Tan	L Sin	′

	Prop. Pts.			
	239	237	235	234
2	47.8	47.4	47.0	46.8
3	71.7	71.1	70.5	70.2
4	95.6	94.8	94.0	93.6
5	119.5	118.5	117.5	117.0
6	143.4	142.2	141.0	140.4
7	167.3	165.9	164.5	163.8
8	191.2	189.6	188.0	187.2
9	215.1	213.3	211.5	210.6
	232	229	227	226
2	46.4	45.8	45.4	45.2
3	69.6	68.7	68.1	67.8
4	92.8	91.6	90.8	90.4
5	116.0	114.5	113.5	113.0
6	139.2	137.4	136.2	135.6
7	162.4	160.3	158.9	158.2
8	185.6	183.2	181.6	180.8
9	208.8	206.1	204.3	203.4
	224	222	220	219
2	44.8	44.4	44.0	43.8
3	67.2	66.6	66.0	65.7
4	89.6	88.8	88.0	87.6
5	112.0	111.0	110.0	109.5
6	134.4	133.2	132.0	131.4
7	156.8	155.4	154.0	153.3
8	179.2	177.6	176.0	175.2
9	201.6	199.8	198.0	197.1
	217	215	213	211
2	43.4	43.0	42.6	42.2
3	65.1	64.5	63.9	63.3
4	86.8	86.0	85.2	84.4
5	108.5	107.5	106.5	105.5
6	130.2	129.0	127.8	126.6
7	151.9	150.5	149.1	147.7
8	173.6	172.0	170.4	168.8
9	195.3	193.5	191.7	189.9
	208	206	203	201
2	41.6	41.2	40.6	40.2
3	62.4	61.8	60.9	60.3
4	83.2	82.4	81.2	80.4
5	104.0	103.0	101.5	100.5
6	124.8	123.6	121.8	120.6
7	145.6	144.2	142.1	140.7
8	166.4	164.8	162.4	160.8
9	187.2	185.4	182.7	180.9
	199	197	195	193
2	39.8	39.4	39.0	38.6
3	59.7	59.1	58.5	57.9
4	79.6	78.8	78.0	77.2
5	99.5	98.5	97.5	96.5
6	119.4	118.2	117.0	115.8
7	139.3	137.9	136.5	135.1
8	159.2	157.6	156.0	154.4
9	179.1	177.3	175.5	173.7
	192	190	188	186
2	38.4	38.0	37.6	37.2
3	57.6	57.0	56.4	55.8
4	76.8	76.0	75.2	74.4
5	96.0	95.0	94.0	93.0
6	115.2	114.0	112.8	111.6
7	134.4	133.0	131.6	130.2
8	153.6	152.0	150.4	148.8
9	172.8	171.0	169.2	167.4
	184	183	182	181
2	36.8	36.6	36.4	36.2
3	55.2	54.9	54.6	54.3
4	73.6	73.2	72.8	72.4
5	92.0	91.5	91.0	90.5
6	110.4	109.8	109.2	108.6
7	128.8	128.1	127.4	126.7
8	147.2	146.4	145.6	144.8
9	165.6	164.7	163.8	162.9

Prop. Pts.

TABLE II

4°

′	L Sin	d	L Tan	c d	L Cot	L Cos		Prop. Pts.
0	8.84 358		8.84 464		11.15 536	9.99 894	60	
		181		182				182 181 180 179
1	8.84 539	179	8.84 646	180	11.15 354	9.99 893	59	2 36.4 36.2 36.0 35.8
2	8.84 718	179	8.84 826	180	11.15 174	9.99 892	58	3 54.6 54.3 54.0 53.7
3	8.84 897		8.85 006		11.14 994	9.99 891	57	4 72.8 72.4 72.0 71.6
		178		179				5 91.0 90.5 90.0 89.5
4	8.85 075	177	8.85 185	178	11.14 815	9.99 891	56	6 109.2 108.6 108.0 107.4
5	8.85 252	177	8.85 363	177	11.14 637	9.99 890	55	7 127.4 126.7 126.0 125.3
6	8.85 429		8.85 540		11.14 460	9.99 889	54	8 145.6 144.8 144.0 143.2
		176		177				9 163.8 162.9 162.0 161.1
7	8.85 605	175	8.85 717	176	11.14 283	9.99 888	53	
8	8.85 780	175	8.85 893	176	11.14 107	9.99 887	52	178 177 176 175
9	8.85 955		8.86 069		11.13 931	9.99 886	51	2 35.6 35.4 35.2 35.0
		173		174				3 53.4 53.1 52.8 52.5
10	8.86 128		8.86 243		11.13 757	9.99 885	50	4 71.2 70.8 70.4 70.0
		173		174				5 89.0 88.5 88.0 87.5
11	8.86 301	173	8.86 417	174	11.13 583	9.99 884	49	6 106.8 106.2 105.6 105.0
12	8.86 474	171	8.86 591	172	11.13 409	9.99 883	48	7 124.6 123.9 123.2 122.5
13	8.86 645		8.86 763		11.13 237	9.99 882	47	8 142.4 141.6 140.8 140.0
		171		172				9 160.2 159.3 158.4 157.5
14	8.86 816	171	8.86 935	171	11.13 065	9.99 881	46	
15	8.86 987	169	8.87 106	171	11.12 894	9.99 880	45	174 173 172 171
16	8.87 156		8.87 277		11.12 723	9.99 879	44	2 34.8 34.6 34.4 34.2
		169		170				3 52.2 51.9 51.6 51.3
17	8.87 325	169	8.87 447	169	11.12 553	9.99 879	43	4 69.6 69.2 68.8 68.4
18	8.87 494	167	8.87 616	169	11.12 384	9.99 878	42	5 87.0 86.5 86.0 85.5
19	8.87 661		8.87 785		11.12 215	9.99 877	41	6 104.4 103.8 103.2 102.6
		168		168				7 121.8 121.1 120.4 119.7
20	8.87 829		8.87 953		11.12 047	9.99 876	40	8 139.2 138.4 137.6 136.8
		166		167				9 156.6 155.7 154.8 153.9
21	8.87 995	166	8.88 120	167	11.11 880	9.99 875	39	
22	8.88 161	165	8.88 287	166	11.11 713	9.99 874	38	170 169 168 167
23	8.88 326		8.88 453		11.11 547	9.99 873	37	2 34.0 33.8 33.6 33.4
		164		165				3 51.0 50.7 50.4 50.1
24	8.88 490	164	8.88 618	165	11.11 382	9.99 872	36	4 68.0 67.6 67.2 66.8
25	8.88 654	163	8.88 783	165	11.11 217	9.99 871	35	5 85.0 84.5 84.0 83.5
26	8.88 817		8.88 948		11.11 052	9.99 870	34	6 102.0 101.4 100.8 100.2
		163		163				7 119.0 118.3 117.6 116.9
27	8.88 980	162	8.89 111	163	11.10 889	9.99 869	33	8 136.0 135.2 134.4 133.6
28	8.89 142	162	8.89 274	163	11.10 726	9.99 868	32	9 153.0 152.1 151.2 150.3
29	8.89 304		8.89 437		11.10 563	9.99 867	31	
		160		161				166 165 164 163
30	8.89 464		8.89 598		11.10 402	9.99 866	30	
		161		162				2 33.2 33.0 32.8 32.6
31	8.89 625	159	8.89 760	160	11.10 240	9.99 865	29	3 49.8 49.5 49.2 48.9
32	8.89 784	159	8.89 920	160	11.10 080	9.99 864	28	4 66.4 66.0 65.6 65.2
33	8.89 943		8.90 080		11.09 920	9.99 863	27	5 83.0 82.5 82.0 81.5
		159		160				6 99.6 99.0 98.4 97.8
34	8.90 102	158	8.90 240	159	11.09 760	9.99 862	26	7 116.2 115.5 114.8 114.1
35	8.90 260	157	8.90 399	158	11.09 601	9.99 861	25	8 132.8 132.0 131.2 130.4
36	8.90 417		8.90 557		11.09 443	9.99 860	24	9 149.4 148.5 147.6 146.7
		157		158				
37	8.90 574	156	8.90 715	157	11.09 285	9.99 859	23	162 161 160 159
38	8.90 730	155	8.90 872	157	11.09 128	9.99 858	22	
39	8.90 885		8.91 029		11.08 971	9.99 857	21	2 32.4 32.2 32.0 31.8
		155		156				3 48.6 48.3 48.0 47.7
40	8.91 040		8.91 185		11.08 815	9.99 856	20	4 64.8 64.4 64.0 63.6
		155		155				5 81.0 80.5 80.0 79.5
41	8.91 195	154	8.91 340	155	11.08 660	9.99 855	19	6 97.2 96.6 96.0 95.4
42	8.91 349	153	8.91 495	155	11.08 505	9.99 854	18	7 113.4 112.7 112.0 111.3
43	8.91 502		8.91 650		11.08 350	9.99 853	17	8 129.6 128.8 128.0 127.2
		153		153				9 145.8 144.9 144.0 143.1
44	8.91 655	152	8.91 803	154	11.08 197	9.99 852	16	
45	8.91 807	152	8.91 957	153	11.08 043	9.99 851	15	158 157 156 155
46	8.91 959		8.92 110		11.07 890	9.99 850	14	
		151		152				2 31.6 31.4 31.2 31.0
47	8.92 110	151	8.92 262	152	11.07 738	9.99 848	13	2 47.4 47.1 46.8 46.5
48	8.92 261	150	8.92 414	151	11.07 586	9.99 847	12	4 63.2 62.8 62.4 62.0
49	8.92 411		8.92 565		11.07 435	9.99 846	11	5 79.0 78.5 78.0 77.5
		150		151				6 94.8 94.2 93.6 93.0
50	8.92 561		8.92 716		11.07 284	9.99 845	10	7 110.6 109.9 109.2 108.5
		149		150				8 126.4 125.6 124.8 124.0
51	8.92 710	149	8.92 866	150	11.07 134	9.99 844	9	9 142.2 141.3 140.4 139.5
52	8.92 859	148	8.93 016	149	11.06 984	9.99 843	8	
53	8.93 007		8.93 165		11.06 835	9.99 842	7	154 153 152
		147		148				
54	8.93 154	147	8.93 313	149	11.06 687	9.99 841	6	2 30.8 30.6 30.4
55	8.93 301	147	8.93 462	147	11.06 538	9.99 840	5	3 46.2 45.9 45.6
56	8.93 448		8.93 609		11.06 391	9.99 839	4	4 61.6 61.2 60.8
		146		147				5 77.0 76.5 76.0
57	8.93 594	146	8.93 756	147	11.06 244	9.99 838	3	6 92.4 91.8 91.2
58	8.93 740	145	8.93 903	146	11.06 097	9.99 837	2	7 107.8 107.1 106.4
59	8.93 885		8.94 049		11.05 951	9.99 836	1	8 123.2 122.4 121.6
		145		146				9 138.6 137.7 136.8
60	8.94 030		8.94 195		11.05 805	9.99 834	0	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	Prop. Pts.

85°

′	L Sin	d	L Tan	c d	L Cot	L Cos		Prop. Pts.			
0	8.94 030		8.94 195		11.05 805	9.99 834	60				
		144		145				151	150	149	148
1	8.94 174	143	8.94 340	145	11.05 660	9.99 833	59	2 30.2	30.0	29.8	29.6
2	8.94 317	144	8.94 485	145	11.05 515	9.99 832	58	3 45.3	45.0	44.7	44.4
3	8.94 461		8.94 630		11.05 370	9.99 831	57	4 60.4	60.0	59.6	59.2
		142		143				5 75.5	75.0	74.5	74.0
4	8.94 603	143	8.94 773	144	11.05 227	9.99 830	56	6 90.6	90.0	89.4	88.8
5	8.94 746	141	8.94 917	143	11.05 083	9.99 829	55	7 105.7	105.0	104.3	103.6
6	8.94 887		8.95 060		11.04 940	9.99 828	54	8 120.8	120.0	119.2	118.4
		142		142				9 135.9	135.0	134.1	133.2
7	8.95 029	141	8.95 202	142	11.04 798	9.99 827	53				
8	8.95 170	140	8.95 344	142	11.04 656	9.99 825	52	147	146	145	144
9	8.95 310		8.95 486	141	11.04 514	9.99 824	51	2 29.4	29.2	29.0	28.8
		140						3 44.1	43.8	43.5	43.2
10	8.95 450		8.95 627	140	11.04 373	9.99 823	50	4 58.8	58.4	58.0	57.6
		139						5 73.5	73.0	72.5	72.0
11	8.95 589	139	8.95 767	141	11.04 233	9.99 822	49	6 88.2	87.6	87.0	86.4
12	8.95 728	139	8.95 908	139	11.04 092	9.99 821	48	7 102.9	102.2	101.5	100.8
13	8.95 867		8.96 047		11.03 953	9.99 820	47	8 117.6	116.8	116.0	115.2
		138		140				9 132.3	131.4	130.5	129.6
14	8.96 005	138	8.96 187	138	11.03 813	9.99 819	46				
15	8.96 143	137	8.96 325	139	11.03 675	9.99 817	45	143	142	141	140
16	8.96 280		8.96 464		11.03 536	9.99 816	44	2 28.6	28.4	28.2	28.0
		137		138				3 42.9	42.6	42.3	42.0
17	8.96 417	136	8.96 602	137	11.03 398	9.99 815	43	4 57.2	56.8	56.4	56.0
18	8.96 553	136	8.96 739	138	11.03 261	9.99 814	42	5 71.5	71.0	70.5	70.0
19	8.96 689		8.96 877		11.03 123	9.99 813	41	6 85.8	85.2	84.6	84.0
		136		136				7 100.1	99.4	98.7	98.0
20	8.96 825		8.97 013		11.02 987	9.99 812	40	8 114.4	113.6	112.8	112.0
		135		137				9 128.7	127.8	126.9	126.0
21	8.96 960	135	8.97 150	135	11.02 850	9.99 810	39				
22	8.97 095	134	8.97 285	136	11.02 715	9.99 809	38	139	138	137	136
23	8.97 229		8.97 421		11.02 579	9.99 808	37	2 27.8	27.6	27.4	27.2
		134		135				3 41.7	41.4	41.1	40.8
24	8.97 363	133	8.97 556	135	11.02 444	9.99 807	36	4 55.6	55.2	54.8	54.4
25	8.97 496	133	8.97 691	134	11.02 309	9.99 806	35	5 69.5	69.0	68.5	68.0
26	8.97 629		8.97 825		11.02 175	9.99 804	34	6 83.4	82.8	82.2	81.6
		133		134				7 97.3	96.6	95.9	95.2
27	8.97 762	132	8.97 959	133	11.02 041	9.99 803	33	8 111.2	110.4	109.6	108.8
28	8.97 894	132	8.98 092	133	11.01 908	9.99 802	32	9 125.1	124.2	123.3	122.4
29	8.98 026		8.98 225		11.01 775	9.99 801	31				
		131		133				135	134	133	132
30	8.98 157		8.98 358		11.01 642	9.99 800	30	2 27.0	26.8	26.6	26.4
		131		132				3 40.5	40.2	39.9	39.6
31	8.98 288	131	8.98 490	132	11.01 510	9.99 798	29	4 54.0	53.6	53.2	52.8
32	8.98 419	130	8.98 622	131	11.01 378	9.99 797	28	5 67.5	67.0	66.5	66.0
33	8.98 549		8.98 753		11.01 247	9.99 796	27	6 81.0	80.4	79.8	79.2
		130		131				7 94.5	93.8	93.1	92.4
34	8.98 679	129	8.98 884	131	11.01 116	9.99 795	26	8 108.0	107.2	106.4	105.6
35	8.98 808	129	8.99 015	130	11.00 985	9.99 793	25	9 121.5	120.6	119.7	118.8
36	8.98 937		8.99 145		11.00 855	9.99 792	24				
		129		130				131	130	129	128
37	8.99 066	128	8.99 275	130	11.00 725	9.99 791	23	2 26.2	26.0	25.8	25.6
38	8.99 194	128	8.99 405	129	11.00 595	9.99 790	22	3 39.3	39.0	38.7	38.4
39	8.99 322		8.99 534		11.00 466	9.99 788	21	4 52.4	52.0	51.6	51.2
		128		128				5 65.5	65.0	64.5	64.0
40	8.99 450		8.99 662		11.00 338	9.99 787	20	6 78.6	78.0	77.4	76.8
		127		129				7 91.7	91.0	90.3	89.6
41	8.99 577	127	8.99 791	128	11.00 209	9.99 786	19	8 104.8	104.0	103.2	102.4
42	8.99 704	126	8.99 919	127	11.00 081	9.99 785	18	9 117.9	117.0	116.1	115.2
43	8.99 830		9.00 046		10.99 954	9.99 783	17				
		126		128				127	126	125	124
44	8.99 956	126	9.00 174	127	10.99 826	9.99 782	16	2 25.4	25.2	25.0	24.8
45	9.00 082	125	9.00 301	126	10.99 699	9.99 781	15	3 38.1	37.8	37.5	37.2
46	9.00 207		9.00 427		10.99 573	9.99 780	14	4 50.8	50.4	50.0	49.6
		125		126				5 63.5	63.0	62.5	62.0
47	9.00 332	124	9.00 553	126	10.99 447	9.99 778	13	6 76.2	75.6	75.0	74.4
48	9.00 456	125	9.00 679	126	10.99 321	9.99 777	12	7 88.9	88.2	87.5	86.8
49	9.00 581		9.00 805		10.99 195	9.99 776	11	8 101.6	100.8	100.0	99.2
		123		125				9 114.3	113.4	112.5	111.6
50	9.00 704		9.00 930		10.99 070	9.99 775	10				
		124		125				123	122	121	120
51	9.00 828	123	9.01 055	124	10.98 945	9.99 773	9	2 24.6	24.4	24.2	24.0
52	9.00 951	123	9.01 179	124	10.98 821	9.99 772	8	3 36.9	36.6	36.3	36.0
53	9.01 074		9.01 303		10.98 697	9.99 771	7	4 49.2	48.8	48.4	48.0
		122		124				5 61.5	61.0	60.5	60.0
54	9.01 196	122	9.01 427	123	10.98 573	9.99 769	6	6 73.8	73.2	72.6	72.0
55	9.01 318	122	9.01 550	123	10.98 450	9.99 768	5	7 86.1	85.4	84.7	84.0
56	9.01 440		9.01 673		10.98 327	9.99 767	4	8 98.4	97.6	96.8	96.0
		121		123				9 110.7	109.8	108.9	108.0
57	9.01 561	121	9.01 796	122	10.98 204	9.99 765	3				
58	9.01 682	121	9.01 918	122	10.98 082	9.99 764	2				
59	9.01 803		9.02 040		10.97 960	9.99 763	1				
		120		122							
60	9.01 923		9.02 162		10.97 838	9.99 761	0				
	L Cos	d	L Cot	c d	L Tan	L Sin	′	Prop. Pts.			

′	L Sin	d	L Tan	c d	L Cot	L Cos		Prop. Pts.
0	9.01 923		9.02 162		10.97 838	9.99 761	60	
1	9.02 043	120	9.02 283	121	10.97 717	9.99 760	59	
2	9.02 163	120	9.02 404	121	10.97 596	9.99 759	58	
3	9.02 283	120	9.02 525	121	10.97 475	9.99 757	57	
4	9.02 402	119	9.02 645	120	10.97 355	9.99 756	56	
5	9.02 520	118	9.02 766	121	10.97 234	9.99 755	55	
6	9.02 639	119	9.02 885	119	10.97 115	9.99 753	54	
7	9.02 757	118	9.03 005	120	10.96 995	9.99 752	53	
8	9.02 874	117	9.03 124	119	10.96 876	9.99 751	52	
9	9.02 992	118	9.03 242	118	10.96 758	9.99 749	51	
10	9.03 109	117	9.03 361	119	10.96 639	9.99 748	50	
11	9.03 226	117	9.03 479	118	10.96 521	9.99 747	49	
12	9.03 342	116	9.03 597	118	10.96 403	9.99 745	48	
13	9.03 458	116	9.03 714	117	10.96 286	9.99 744	47	
14	9.03 574	116	9.03 832	118	10.96 168	9.99 742	46	
15	9.03 690	116	9.03 948	116	10.96 052	9.99 741	45	
16	9.03 805	115	9.04 065	117	10.95 935	9.99 740	44	
17	9.03 920	115	9.04 181	116	10.95 819	9.99 738	43	
18	9.04 034	114	9.04 297	116	10.95 703	9.99 737	42	
19	9.04 149	115	9.04 413	116	10.95 587	9.99 736	41	
20	9.04 262	113	9.04 528	115	10.95 472	9.99 734	40	
21	9.04 376	114	9.04 643	115	10.95 357	9.99 733	39	
22	9.04 490	114	9.04 758	115	10.95 242	9.99 731	38	
23	9.04 603	113	9.04 873	115	10.95 127	9.99 730	37	
24	9.04 715	112	9.04 987	114	10.95 013	9.99 728	36	
25	9.04 828	113	9.05 101	114	10.94 899	9.99 727	35	
26	9.04 940	112	9.05 214	113	10.94 786	9.99 726	34	
27	9.05 052	112	9.05 328	114	10.94 672	9.99 724	33	
28	9.05 164	112	9.05 441	113	10.94 559	9.99 723	32	
29	9.05 275	111	9.05 553	112	10.94 447	9.99 721	31	
30	9.05 386	111	9.05 666	113	10.94 334	9.99 720	30	
31	9.05 497	110	9.05 778	112	10.94 222	9.99 718	29	
32	9.05 607	110	9.05 890	112	10.94 110	9.99 717	28	
33	9.05 717	110	9.06 002	112	10.93 998	9.99 716	27	
34	9.05 827	110	9.06 113	111	10.93 887	9.99 714	26	
35	9.05 937	109	9.06 224	111	10.93 776	9.99 713	25	
36	9.06 046	109	9.06 335	111	10.93 665	9.99 711	24	
37	9.06 155	109	9.06 445	110	10.93 555	9.99 710	23	
38	9.06 264	108	9.06 556	111	10.93 444	9.99 708	22	
39	9.06 372	109	9.06 666	110	10.93 334	9.99 707	21	
40	9.06 481	108	9.06 775	109	10.93 225	9.99 705	20	
41	9.06 589	107	9.06 885	110	10.93 115	9.99 704	19	
42	9.06 696	108	9.06 994	109	10.93 006	9.99 702	18	
43	9.06 804	107	9.07 103	109	10.92 897	9.99 701	17	
44	9.06 911	107	9.07 211	108	10.92 789	9.99 699	16	
45	9.07 018	106	9.07 320	109	10.92 680	9.99 698	15	
46	9.07 124	107	9.07 428	108	10.92 572	9.99 696	14	
47	9.07 231	106	9.07 536	108	10.92 464	9.99 695	13	
48	9.07 337	105	9.07 643	107	10.92 357	9.99 693	12	
49	9.07 442	106	9.07 751	108	10.92 249	9.99 692	11	
50	9.07 548	105	9.07 858	107	10.92 142	9.99 690	10	
51	9.07 653	105	9.07 964	106	10.92 036	9.99 689	9	
52	9.07 758	105	9.08 071	107	10.91 929	9.99 687	8	
53	9.07 863	105	9.08 177	106	10.91 823	9.99 686	7	
54	9.07 968	104	9.08 283	106	10.91 717	9.99 684	6	
55	9.08 072	104	9.08 389	106	10.91 611	9.99 683	5	
56	9.08 176	104	9.08 495	106	10.91 505	9.99 681	4	
57	9.08 280	103	9.08 600	105	10.91 400	9.99 680	3	
58	9.08 383	103	9.08 705	105	10.91 295	9.99 678	2	
59	9.08 486	103	9.08 810	105	10.91 190	9.99 677	1	
60	9.08 589		9.08 914	104	10.91 086	9.99 675	0	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	Prop. Pts.

	121	120	119
1	12.1	12.0	11.9
2	24.2	24.0	23.8
3	36.3	36.0	35.7
4	48.4	48.0	47.6
5	60.5	60.0	59.5
6	72.6	72.0	71.4
7	84.7	84.0	83.3
8	96.8	96.0	95.2
9	108.9	108.0	107.1

	118	117	116
1	11.8	11.7	11.6
2	23.6	23.4	23.2
3	35.4	35.1	34.8
4	47.2	46.8	46.4
5	59.0	58.5	58.0
6	70.8	70.2	69.6
7	82.6	81.9	81.2
8	94.4	93.6	92.8
9	106.2	105.3	104.4

	115	114	113
1	11.5	11.4	11.3
2	23.0	22.8	22.6
3	34.5	34.2	33.9
4	46.0	45.6	45.2
5	57.5	57.0	56.5
6	69.0	68.4	67.8
7	80.5	79.8	79.1
8	92.0	91.2	90.4
9	103.5	102.6	101.7

	112	111	110
1	11.2	11.1	11.0
2	22.4	22.2	22.0
3	33.6	33.3	33.0
4	44.8	44.4	44.0
5	56.0	55.5	55.0
6	67.2	66.6	66.0
7	78.4	77.7	77.0
8	89.6	88.8	88.0
9	100.8	99.9	99.0

	109	108	107	106
1	10.9	10.8	10.7	10.6
2	21.8	21.6	21.4	21.2
3	32.7	32.4	32.1	31.8
4	43.6	43.2	42.8	42.4
5	54.5	54.0	53.5	53.0
6	65.4	64.8	64.2	63.6
7	76.3	75.6	74.9	74.2
8	87.2	86.4	85.6	84.8
9	98.1	97.2	96.3	95.4

′	L Sin	d	L Tan	c d	L Cot	L Cos		Prop. Pts.
0	9.08 589		9.08 914		10.91 086	9.99 675	60	
1	9.08 692	103	9.09 019	105	10.90 981	9.99 674	59	
2	9.08 795	103	9.09 123	104	10.90 877	9 99 672	58	
3	9.08 897	102	9.09 227	104	10.90 773	9.99 670	57	105 | 104 | 103
4	9.08 999	102	9.09 330	103	10.90 670	9.99 669	56	1 | 10.5 | 10.4 | 10.3
5	9.09 101	101	9.09 434	104	10.90 566	9.99 667	55	2 | 21.0 | 20.8 | 20.6
6	9.09 202		9.09 537	103	10.90 463	9.99 666	54	3 | 31.5 | 31.2 | 30.9
7	9.09 304	102	9.09 640	103	10.90 360	9.99 664	53	4 | 42.0 | 41.6 | 41.2
8	9.09 405	101	9.09 742	102	10.90 258	9.99 663	52	5 | 52.5 | 52.0 | 51.5
9	9.09 506	101	9.09 845	103	10.90 155	9.99 661	51	6 | 63.0 | 62.4 | 61.8
10	9.09 606	100	9.09 947	102	10.90 053	9.99 659	50	7 | 73.5 | 72.8 | 72.1
11	9.09 707	101	9.10 049	102	10.89 951	9.99 658	49	8 | 84.0 | 83.2 | 82.4
12	9.09 807	100	9.10 150	101	10.89 850	9.99 656	48	9 | 94.5 | 93.6 | 92.7
13	9.09 907	100	9.10 252	102	10.89 748	9.99 655	47	
14	9.10 006	99	9.10 353	101	10.89 647	9.99 653	46	
15	9.10 106	100	9.10 454	101	10.89 546	9.99 651	45	102 | 101 | 99
16	9.10 205	99	9.10 555		10.89 445	9.99 650	44	1 | 10.2 | 10.1 | 9.9
17	9.10 304	99	9.10 656	101	10.89 344	9.99 648	43	2 | 20.4 | 20.2 | 19.8
18	9.10 402	98	9.10 756	100	10.89 244	9.99 647	42	3 | 30.6 | 30.3 | 29.7
19	9.10 501	99	9.10 856	100	10.89 144	9.99 645	41	4 | 40.8 | 40.4 | 39.6
20	9.10 599	98	9.10 956	100	10.89 044	9.99 643	40	5 | 51.0 | 50.5 | 49.5
21	9.10 697	98	9.11 056	100	10.88 944	9.99 642	39	6 | 61.2 | 60.6 | 59.4
22	9.10 795	98	9.11 155	99	10.88 845	9.99 640	38	7 | 71.4 | 70.7 | 69.3
23	9.10 893	97	9.11 254	99	10.88 746	9.99 638	37	8 | 81.6 | 80.8 | 79.2
24	9.10 990	97	9.11 353	99	10.88 647	9.99 637	36	9 | 91.8 | 90.9 | 89.1
25	9.11 087	97	9.11 452	99	10.88 548	9.99 635	35	
26	9.11 184	97	9.11 551	99	10.88 449	9.99 633	34	
27	9.11 281	96	9.11 649	98	10.88 351	9.99 632	33	98 | 97 | 96
28	9.11 377	97	9.11 747	98	10.88 253	9.99 630	32	1 | 9.8 | 9.7 | 9.6
29	9.11 474	96	9.11 845	98	10.88 155	9.99 629	31	2 | 19.6 | 19.4 | 19.2
30	9.11 570	96	9.11 943	97	10.88 057	9.99 627	30	3 | 29.4 | 29.1 | 28.8
31	9.11 666	95	9.12 040	98	10.87 960	9.99 625	29	4 | 39.2 | 38.8 | 38.4
32	9.11 761	96	9.12 138	97	10.87 862	9.99 624	28	5 | 49.0 | 48.5 | 48.0
33	9.11 857	95	9.12 235	97	10.87 765	9.99 622	27	6 | 58.8 | 58.2 | 57.6
34	9.11 952	95	9.12 332	96	10.87 668	9.99 620	26	7 | 68.6 | 67.9 | 67.2
35	9.12 047	95	9.12 428	97	10.87 572	9.99 618	25	8 | 78.4 | 77.6 | 76.8
36	9.12 142	94	9.12 525	96	10.87 475	9.99 617	24	9 | 88.2 | 87.3 | 86.4
37	9.12 236	95	9.12 621	96	10.87 379	9.99 615	23	
38	9.12 331	94	9.12 717	96	10.87 283	9.99 613	22	
39	9.12 425	94	9.12 813	96	10.87 187	9.99 612	21	95 | 94 | 93
40	9.12 519	93	9.12 909	95	10.87 091	9.99 610	20	1 | 9.5 | 9.4 | 9.3
41	9.12 612	94	9.13 004	95	10.86 996	9.99 608	19	2 | 19.0 | 18.8 | 18.6
42	9.12 706	93	9.13 099	95	10.86 901	9.99 607	18	3 | 28.5 | 28.2 | 27.9
43	9.12 799	93	9.13 194	95	10.86 806	9.99 605	17	4 | 38.0 | 37.6 | 37.2
44	9.12 892	93	9.13 289	95	10.86 711	9.99 603	16	5 | 47.5 | 47.0 | 46.5
45	9.12 985	93	9.13 384	94	10.86 616	9.99 601	15	6 | 57.0 | 56.4 | 55.8
46	9.13 078	93	9.13 478	95	10.86 522	9.99 600	14	7 | 66.5 | 65.8 | 65.1
47	9 13 171	92	9.13 573	94	10.86 427	9.99 598	13	8 | 76.0 | 75.2 | 74.4
48	9.13 263	92	9.13 667	94	10.86 333	9.99 596	12	9 | 85.5 | 84.6 | 83.7
49	9.13 355	92	9.13 761	93	10.86 239	9.99 595	11	
50	9.13 447	92	9.13 854	94	10.86 146	9.99 593	10	92 | 91 | 90
51	9.13 539	91	9.13 948	93	10.86 052	9.99 591	9	1 | 9.2 | 9.1 | 9.0
52	9.13 630	92	9.14 041	93	10.85 959	9.99 589	8	2 | 18.4 | 18.2 | 18.0
53	9.13 722	91	9.14 134	93	10.85 866	9.99 588	7	3 | 27.6 | 27.3 | 27.0
54	9.13 813	91	9.14 227	93	10.85 773	9.99 586	6	4 | 36.8 | 36.4 | 36.0
55	9.13 904	90	9.14 320	92	10.85 680	9.99 584	5	5 | 46.0 | 45.5 | 45.0
56	9.13 994	91	9.14 412	92	10.85 588	9.99 582	4	6 | 55.2 | 54.6 | 54.0
57	9.14 085	90	9.14 504	93	10.85 496	9.99 581	3	7 | 64.4 | 63.7 | 63.0
58	9.14 175	91	9.14 597	91	10.85 403	9.99 579	2	8 | 73.6 | 72.8 | 72.0
59	9.14 266	90	9.14 688	92	10.85 312	9.99 577	1	9 | 82.8 | 81.9 | 81.0
60	9.14 356		9.14 780		10.85 220	9.99 575	0	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	Prop. Pts.

TABLE II

8°

′	L Sin	d	L Tan	c d	L Cot	L Cos		′
0	9.14 356	89	9.14 780	92	10.85 220	9.99 575	**60**	
1	9.14 445	90	9.14 872	91	10.85 128	9.99 574	59	
2	9.14 535	89	9.14 963	91	10.85 037	9.99 572	58	
3	9.14 624	90	9.15 054	91	10.84 946	9.99 570	57	
4	9.14 714	89	9.15 145	91	10.84 855	9.99 568	56	
5	9.14 803	88	9.15 236	91	10.84 764	9.99 566	55	
6	9.14 891	89	9.15 327	90	10.84 673	9.99 565	54	
7	9.14 980	89	9.15 417	91	10.84 583	9.99 563	53	
8	9.15 069	88	9.15 508	90	10.84 492	9.99 561	52	
9	9.15 157	88	9.15 598	90	10.84 402	9.99 559	51	
10	9.15 245	88	9.15 688	89	10.84 312	9.99 557	**50**	
11	9.15 333	88	9.15 777	90	10.84 223	9.99 556	49	
12	9.15 421	87	9.15 867	89	10.84 133	9.99 554	48	
13	9.15 508	88	9.15 956	90	10.84 044	9.99 552	47	
14	9.15 596	87	9.16 046	89	10.83 954	9.99 550	46	
15	9.15 683	87	9.16 135	89	10.83 865	9.99 548	45	
16	9.15 770	87	9.16 224	88	10.83 776	9.99 546	44	
17	9.15 857	87	9.16 312	89	10.83 688	9.99 545	43	
18	9.15 944	86	9.16 401	88	10.83 599	9.99 543	42	
19	9.16 030	86	9.16 489	88	10.83 511	9.99 541	41	
20	9.16 116	87	9.16 577	88	10.83 423	9.99 539	**40**	
21	9.16 203	86	9.16 665	88	10.83 335	9.99 537	39	
22	9.16 289	85	9.16 753	88	10.83 247	9.99 535	38	
23	9.16 374	86	9.16 841	87	10.83 159	9.99 533	37	
24	9.16 460	85	9.16 928	88	10.83 072	9.99 532	36	
25	9.16 545	86	9.17 016	87	10.82 984	9.99 530	35	
26	9.16 631	85	9.17 103	87	10.82 897	9.99 528	34	
27	9.16 716	85	9.17 190	87	10.82 810	9.99 526	33	
28	9.16 801	85	9.17 277	86	10.82 723	9.99 524	32	
29	9.16 886	84	9.17 363	87	10.82 637	9.99 522	31	
30	9.16 970	85	9.17 450	86	10.82 550	9.99 520	**30**	
31	9.17 055	84	9.17 536	86	10.82 464	9.99 518	29	
32	9.17 139	84	9.17 622	86	10.82 378	9.99 517	28	
33	9.17 223	84	9.17 708	86	10.82 292	9.99 515	27	
34	9.17 307	84	9.17 794	86	10.82 206	9.99 513	26	
35	9.17 391	83	9.17 880	85	10.82 120	9.99 511	25	
36	9.17 474	84	9.17 965	86	10.82 035	9.99 509	24	
37	9.17 558	83	9.18 051	85	10.81 949	9.99 507	23	
38	9.17 641	83	9.18 136	85	10.81 864	9.99 505	22	
39	9.17 724	83	9.18 221	85	10.81 779	9.99 503	21	
40	9.17 807	83	9.18 306	85	10.81 694	9.99 501	**20**	
41	9.17 890	83	9.18 391	84	10.81 609	9.99 499	19	
42	9.17 983	82	9.18 475	85	10.81 525	9.99 497	18	
43	9.18 055	82	9.18 560	84	10.81 440	9.99 495	17	
44	9.18 137	83	9.18 644	84	10.81 356	9.99 494	16	
45	9.18 220	82	9.18 728	84	10.81 272	9.99 492	15	
46	9.18 302	81	9.18 812	84	10.81 188	9.99 490	14	
47	9.18 383	82	9.18 896	83	10.81 104	9.99 488	13	
48	9.18 465	82	9.18 979	84	10.81 021	9.99 486	12	
49	9.18 547	81	9.19 063	83	10.80 937	9.99 484	11	
50	9.18 628	81	9.19 146	83	10.80 854	9.99 482	**10**	
51	9.18 709	81	9.19 229	83	10.80 771	9.99 480	9	
52	9.18 790	81	9.19 312	83	10.80 688	9.99 478	8	
53	9.18 871	81	9.19 395	83	10.80 605	9.99 476	7	
54	9.18 952	81	9.19 478	83	10.80 522	9.99 474	6	
55	9.19 033	80	9.19 561	82	10.80 439	9.99 472	5	
56	9.19 113	80	9.19 643	82	10.80 357	9.99 470	4	
57	9.19 193	80	9.19 725	82	10.80 275	9.99 468	3	
58	9.19 273	80	9.19 807	82	10.80 193	9.99 466	2	
59	9.19 353	80	9.19 889	82	10.80 111	9.99 464	1	
60	9.19 433		9.19 971		10.80 029	9.99 462	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	

Prop. Pts.

	92	91	90
1	9.2	9.1	9.0
2	18.4	18.2	18.0
3	27.6	27.3	27.0
4	36.8	36.4	36.0
5	46.0	45.5	45.0
6	55.2	54.6	54.0
7	64.4	63.7	63.0
8	73.6	72.8	72.0
9	82.8	81.9	81.0

	89	88	87
1	8.9	8.8	8.7
2	17.8	17.6	17.4
3	26.7	26.4	26.1
4	35.6	35.2	34.8
5	44.5	44.0	43.5
6	53.4	52.8	52.2
7	62.3	61.6	60.9
8	71.2	70.4	69.6
9	80.1	79.2	78.3

	86	85	84
1	8.6	8.5	8.4
2	17.2	17.0	16.8
3	25.8	25.5	25.2
4	34.4	34.0	33.6
5	43.0	42.5	42.0
6	51.6	51.0	50.4
7	60.2	59.5	58.8
8	68.8	68.0	67.2
9	77.4	76.5	75.6

	83	82	81	80
1	8.3	8.2	8.1	8.0
2	16.6	16.4	16.2	16.0
3	24.9	24.6	24.3	24.0
4	33.2	32.8	32.4	32.0
5	41.5	41.0	40.5	40.0
6	49.8	49.2	48.6	48.0
7	58.1	57.4	56.7	56.0
8	66.4	65.6	64.8	64.0
9	74.7	73.8	72.9	72.0

Prop. Pts.

81°

′	L Sin	d	L Tan	c d	L Cot	L Cos		Prop. Pts.
0	9.19 433		9.19 971		10.80 029	9.99 462	**60**	
		80		82				
1	9.19 513	79	9.20 053	81	10.79 947	9.99 460	59	
2	9.19 592	80	9.20 134	82	10.79 866	9.99 458	58	
3	9.19 672	79	9.20 216	81	10.79 784	9.99 456	57	
4	9.19 751	79	9.20 297	81	10.79 703	9.99 454	56	
5	9.19 830	79	9.20 378	81	10.79 622	9.99 452	55	
6	9.19 909	79	9.20 459	81	10.79 541	9.99 450	54	
7	9.19 988	79	9.20 540	81	10.79 460	9.99 448	53	
8	9.20 067	78	9.20 621	80	10.79 379	9.99 446	52	
9	9.20 145	78	9.20 701	81	10.79 299	9.99 444	51	
10	9.20 223	79	9.20 782	80	10.79 218	9.99 442	**50**	
11	9.20 302	78	9.20 862	80	10.79 138	9.99 440	49	
12	9.20 380	78	9.20 942	80	10.79 058	9.99 438	48	
13	9.20 458	77	9.21 022	80	10.78 978	9.99 436	47	
14	9.20 535	78	9.21 102	80	10.78 898	9.99 434	46	
15	9.20 613	78	9.21 182	79	10.78 818	9.99 432	45	
16	9.20 691	77	9.21 261	80	10.78 739	9.99 429	44	
17	9.20 768	77	9.21 341	79	10.78 659	9.99 427	43	
18	9.20 845	77	9.21 420	79	10.78 580	9.99 425	42	
19	9.20 922	77	9.21 499	79	10.78 501	9.99 423	41	
20	9.20 999	77	9.21 578	79	10.78 422	9.99 421	**40**	
21	9.21 076	77	9.21 657	79	10.78 343	9.99 419	39	
22	9.21 153	76	9.21 736	78	10.78 264	9.99 417	38	
23	9.21 229	77	9.21 814	79	10.78 186	9.99 415	37	
24	9.21 306	76	9.21 893	78	10.78 107	9.99 413	36	
25	9.21 382	76	9.21 971	78	10.78 029	9.99 411	35	
26	9.21 458	76	9.22 049	78	10.77 951	9.99 409	34	
27	9.21 534	76	9.22 127	78	10.77 873	9.99 407	33	
28	9.21 610	75	9.22 205	78	10.77 795	9.99 404	32	
29	9.21 685	76	9.22 283	78	10.77 717	9.99 402	31	
30	9.21 761	75	9.22 361	77	10.77 639	9.99 400	**30**	
31	9.21 836	76	9.22 438	78	10.77 562	9.99 398	29	
32	9.21 912	75	9.22 516	77	10.77 484	9.99 396	28	
33	9.21 987	75	9.22 593	77	10.77 407	9.99 394	27	
34	9.22 062	75	9.22 670	77	10.77 330	9.99 392	26	
35	9.22 137	74	9.22 747	77	10.77 253	9.99 390	25	
36	9.22 211	75	9.22 824	77	10.77 176	9.99 388	24	
37	9.22 286	75	9.22 901	76	10.77 099	9.99 385	23	
38	9.22 361	74	9.22 977	77	10.77 023	9.99 383	22	
39	9.22 435	74	9.23 054	76	10.76 946	9.99 381	21	
40	9.22 509	74	9.23 130	76	10.76 870	9.99 379	**20**	
41	9.22 583	74	9.23 206	77	10.76 794	9.99 377	19	
42	9.22 657	74	9.23 283	76	10.76 717	9.99 375	18	
43	9.22 731	74	9.23 359	76	10.76 641	9.99 372	17	
44	9.22 805	73	9.23 435	75	10.76 565	9.99 370	16	
45	9.22 878	74	9.23 510	76	10.76 490	9.99 368	15	
46	9.22 952	73	9.23 586	75	10.76 414	9.99 366	14	
47	9.23 025	73	9.23 661	76	10.76 339	9.99 364	13	
48	9.23 098	73	9.23 737	75	10.76 263	9.99 362	12	
49	9.23 171	73	9.23 812	75	10.76 188	9.99 359	11	
50	9.23 244	73	9.23 887	75	10.76 113	9.99 357	**10**	
51	9.23 317	73	9.23 962	75	10.76 038	9.99 355	9	
52	9.23 390	72	9.24 037	75	10.75 963	9.99 353	8	
53	9.23 462	73	9.24 112	74	10.75 888	9.99 351	7	
54	9.23 535	72	9.24 186	75	10.75 814	9.99 348	6	
55	9.23 607	72	9.24 261	74	10.75 739	9.99 346	5	
56	9.23 679	73	9.24 335	75	10.75 665	9.99 344	4	
57	9.23 752	71	9.24 410	74	10.75 590	9.99 342	3	
58	9.23 823	72	9.24 484	74	10.75 516	9.99 340	2	
59	9.23 895	72	9.24 558	74	10.75 442	9.99 337	1	
60	9.23 967		9.24 632		10.75 368	9.99 335	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	′	Prop. Pts.

	82	81	80
1	8.2	8.1	8.0
2	16.4	16.2	16.0
3	24.6	24.3	24.0
4	32.8	32.4	32.0
5	41.0	40.5	40.0
6	49.2	48.6	48.0
7	57.4	56.7	56.0
8	65.6	64.8	64.0
9	73.8	72.9	72.0

	79	78	77
1	7.9	7.8	7.7
2	15.8	15.6	15.4
3	23.7	23.4	23.1
4	31.6	31.2	30.8
5	39.5	39.0	38.5
6	47.4	46.8	46.2
7	55.3	54.6	53.9
8	63.2	62.4	61.6
9	71.1	70.2	69.3

	76	75	74
1	7.6	7.5	7.4
2	15.2	15.0	14.8
3	22.8	22.5	22.2
4	30.4	30.0	29.6
5	38.0	37.5	37.0
6	45.6	45.0	44.4
7	53.2	52.5	51.8
8	60.8	60.0	59.2
9	68.4	67.5	66.6

	73	72	71
1	7.3	7.2	7.1
2	14.6	14.4	14.2
3	21.9	21.6	21.3
4	29.2	28.8	28.4
5	36.5	36.0	35.5
6	43.8	43.2	42.6
7	51.1	50.4	49.7
8	58.4	57.6	56.8
9	65.7	64.8	63.9

	3	2
1	0.3	0.2
2	0.6	0.4
3	0.9	0.6
4	1.2	0.8
5	1.5	1.0
6	1.8	1.2
7	2.1	1.4
8	2.4	1.6
9	2.7	1.8

TABLE II

10°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.23 967		9.24 632		10.75 368	9.99 335		**60**	
1	9.24 039	72	9.24 706	74	10.75 294	9.99 333	2	59	
2	9.24 110	71	9.24 779	73	10.75 221	9.99 331	2	58	
3	9.24 181	71	9.24 853	74	10.75 147	9.99 328	3	57	
4	9.24 253	72	9.24 926	73	10.75 074	9.99 326	2	56	
5	9.24 324	71	9.25 000	74	10.75 000	9.99 324	2	55	
6	9.24 395	71	9.25 073	73	10.74 927	9.99 322	2	54	
7	9.24 466	71	9.25 146	73	10.74 854	9.99 319	3	53	
8	9.24 536	70	9.25 219	73	10.74 781	9.99 317	2	52	
9	9.24 607	71	9.25 292	73	10.74 708	9.99 315	2	51	
10	9.24 677	70	9.25 365	72	10.74 635	9.99 313	2	**50**	
11	9.24 748	71	9.25 437	73	10.74 563	9.99 310	3	49	
12	9.24 818	70	9.25 510	72	10.74 490	9.99 308	2	48	
13	9.24 888	70	9.25 582	73	10.74 418	9.99 306	2	47	
14	9.24 958	70	9.25 655	72	10.74 345	9.99 304	2	46	
15	9.25 028	70	9.25 727	72	10.74 273	9.99 301	3	45	
16	9.25 098	70	9.25 799	72	10.74 201	9.99 299	2	44	
17	9.25 168	69	9.25 871	72	10.74 129	9.99 297	2	43	
18	9.25 237	70	9.25 943	72	10.74 057	9.99 294	3	42	
19	9.25 307	69	9.26 015	71	10.73 985	9.99 292	2	41	
20	9.25 376	69	9.26 086	72	10.73 914	9.99 290	2	**40**	
21	9.25 445	69	9.26 158	71	10.73 842	9.99 288	2	39	
22	9.25 514	69	9.26 229	72	10.73 771	9.99 285	3	38	
23	9.25 583	69	9.26 301	71	10.73 699	9.99 283	2	37	
24	9.25 652	69	9.26 372	71	10.73 628	9.99 281	2	36	
25	9.25 721	69	9.26 443	71	10.73 557	9.99 278	3	35	
26	9.25 790	68	9.26 514	71	10.73 486	9.99 276	2	34	
27	9.25 858	69	9.26 585	70	10.73 415	9.99 274	2	33	
28	9.25 927	68	9.26 655	71	10.73 345	9.99 271	3	32	
29	9.25 995	68	9.26 726	71	10.73 274	9.99 269	2	31	
30	9.26 063	68	9.26 797	70	10.73 203	9.99 267	2	**30**	
31	9.26 131	68	9.26 867	70	10.73 133	9.99 264	3	29	
32	9.26 199	68	9.26 937	71	10.73 063	9.99 262	2	28	
33	9.26 267	68	9.27 008	70	10.72 992	9.99 260	2	27	
34	9.26 335	68	9.27 078	70	10.72 922	9.99 257	3	26	
35	9.26 403	67	9.27 148	70	10.72 852	9.99 255	2	25	
36	9.26 470	68	9.27 218	70	10.72 782	9.99 252	3	24	
37	9.26 538	67	9.27 288	69	10.72 712	9.99 250	2	23	
38	9.26 605	67	9.27 357	70	10.72 643	9.99 248	2	22	
39	9.26 672	67	9.27 427	69	10.72 573	9.99 245	3	21	
40	9.26 739	67	9.27 496	70	10.72 504	9.99 243	2	**20**	
41	9.26 806	67	9.27 566	69	10.72 434	9.99 241	2	19	
42	9.26 873	67	9.27 635	69	10.72 365	9.99 238	3	18	
43	9.26 940	67	9.27 704	69	10.72 296	9.99 236	2	17	
44	9.27 007	66	9.27 773	69	10.72 227	9.99 233	3	16	
45	9.27 073	67	9.27 842	69	10.72 158	9.99 231	2	15	
46	9.27 140	66	9.27 911	69	10.72 089	9.99 229	2	14	
47	9.27 206	67	9.27 980	69	10.72 020	9.99 226	3	13	
48	9.27 273	66	9.28 049	68	10.71 951	9.99 224	2	12	
49	9.27 339	66	9.28 117	69	10.71 883	9.99 221	3	11	
50	9.27 405	66	9.28 186	68	10.71 814	9.99 219	2	**10**	
51	9.27 471	66	9.28 254	69	10.71 746	9.99 217	2	9	
52	9.27 537	65	9.28 323	68	10.71 677	9.99 214	3	8	
53	9.27 602	66	9.28 391	68	10.71 609	9.99 212	2	7	
54	9.27 668	66	9.28 459	68	10.71 541	9.99 209	3	6	
55	9.27 734	65	9.28 527	68	10.71 473	9.99 207	2	5	
56	9.27 799	65	9.28 595	67	10.71 405	9.99 204	3	4	
57	9.27 864	66	9.28 662	68	10.71 338	9.99 202	2	3	
58	9.27 930	65	9.28 730	68	10.71 270	9.99 200	2	2	
59	9.27 995	65	9.28 798	67	10.71 202	9.99 197	3	1	
60	9.28 060		9.28 865		10.71 135	9.99 195	2	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	74	73	72
1	7.4	7.3	7.2
2	14.8	14.6	14.4
3	22.2	21.9	21.6
4	29.6	29.2	28.8
5	37.0	36.5	36.0
6	44.4	43.8	43.2
7	51.8	51.1	50.4
8	59.2	58.4	57.6
9	66.6	65.7	64.8

	71	70	69
1	7.1	7.0	6.9
2	14.2	14.0	13.8
3	21.3	21.0	20.7
4	28.4	28.0	27.6
5	35.5	35.0	34.5
6	42.6	42.0	41.4
7	49.7	49.0	48.3
8	56.8	56.0	55.2
9	63.9	63.0	62.1

	68	67	66
1	6.8	6.7	6.6
2	13.6	13.4	13.2
3	20.4	20.1	19.8
4	27.2	26.8	26.4
5	34.0	33.5	33.0
6	40.8	40.2	39.6
7	47.6	46.9	46.2
8	54.4	53.6	52.8
9	61.2	60.3	59.4

	65	3	2
1	6.5	0.3	0.2
2	13.0	0.6	0.4
3	19.5	0.9	0.6
4	26.0	1.2	0.8
5	32.5	1.5	1.0
6	39.0	1.8	1.2
7	45.5	2.1	1.4
8	52.0	2.4	1.6
9	58.5	2.7	1.8

79°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.28 060		9.28 865		10.71 135	9.99 195		**60**	
1	9.28 125	65	9.28 933	68	10.71 067	9.99 192	3	59	
2	9.28 190	65	9.29 000	67	10.71 000	9.99 190	2	58	
3	9.28 254	64	9.29 067	67	10.70 933	9.99 187	3	57	
4	9.28 319	65	9.29 134	67	10.70 866	9.99 185	2	56	
5	9.28 384	65	9.29 201	67	10.70 799	9.99 182	3	55	
6	9.28 448	64	9.29 268	67	10.70 732	9.99 180	2	54	
7	9.28 512	64	9.29 335	67	10.70 665	9.99 177	3	53	
8	9.28 577	65	9.29 402	67	10.70 598	9.99 175	2	52	
9	9.28 641	64	9.29 468	66	10.70 532	9.99 172	3	51	
10	9.28 705	64	9.29 535	67	10.70 465	9.99 170	2	**50**	
11	9.28 769	64	9.29 601	66	10.70 399	9.99 167	3	49	
12	9.28 833	64	9.29 668	67	10.70 332	9.99 165	2	48	
13	9.28 896	63	9.29 734	66	10.70 266	9.99 162	3	47	
14	9.28 960	64	9.29 800	66	10.70 200	9.99 160	2	46	
15	9.29 024	64	9.29 866	66	10.70 134	9.99 157	3	45	
16	9.29 087	63	9.29 932	66	10.70 068	9.99 155	2	44	
17	9.29 150	63	9.29 998	66	10.70 002	9.99 152	3	43	
18	9.29 214	64	9.30 064	66	10.69 936	9.99 150	2	42	
19	9.29 277	63	9.30 130	66	10.69 870	9.99 147	3	41	
20	9.29 340	63	9.30 195	65	10.69 805	9.99 145	2	**40**	
21	9.29 403	63	9.30 261	66	10.69 739	9.99 142	3	39	
22	9.29 466	63	9.30 326	65	10.69 674	9.99 140	2	38	
23	9.29 529	63	9.30 391	65	10.69 609	9.99 137	3	37	
24	9.29 591	62	9.30 457	66	10.69 543	9.99 135	2	36	
25	9.29 654	63	9.30 522	65	10.69 478	9.99 132	3	35	
26	9.29 716	62	9.30 587	65	10.69 413	9.99 130	2	34	
27	9.29 779	63	9.30 652	65	10.69 348	9.99 127	3	33	
28	9.29 841	62	9.30 717	65	10.69 283	9.99 124	3	32	
29	9.29 903	62	9.30 782	65	10.69 218	9.99 122	2	31	
30	9.29 966	63	9.30 846	64	10.69 154	9.99 119	3	**30**	
31	9.30 028	62	9.30 911	65	10.69 089	9.99 117	2	29	
32	9.30 090	62	9.30 975	64	10.69 025	9.99 114	3	28	
33	9.30 151	61	9.31 040	65	10.68 960	9.99 112	2	27	
34	9.30 213	62	9.31 104	64	10.68 896	9.99 109	3	26	
35	9.30 275	62	9.31 168	64	10.68 832	9.99 106	3	25	
36	9.30 336	61	9.31 233	65	10.68 767	9.99 104	2	24	
37	9.30 398	62	9.31 297	64	10.68 703	9.99 101	3	23	
38	9.30 459	61	9.31 361	64	10.68 639	9.99 099	2	22	
39	9.30 521	62	9.31 425	64	10.68 575	9.99 096	3	21	
40	9.30 582	61	9.31 489	64	10.68 511	9.99 093	3	**20**	
41	9.30 643	61	9.31 552	63	10.68 448	9.99 091	2	19	
42	9.30 704	61	9.31 616	64	10.68 384	9.99 088	3	18	
43	9.30 765	61	9.31 679	63	10.68 321	9.99 086	2	17	
44	9.30 826	61	9.31 743	64	10.68 257	9.99 083	3	16	
45	9.30 887	60	9.31 806	63	10.68 194	9.99 080	3	15	
46	9.30 947	61	9.31 870	64	10.68 130	9.99 078	2	14	
47	9.31 008	60	9.31 933	63	10.68 067	9.99 075	3	13	
48	9.31 068	61	9.31 996	63	10.68 004	9.99 072	3	12	
49	9.31 129	60	9.32 059	63	10.67 941	9.99 070	2	11	
50	9.31 189	61	9.32 122	63	10.67 878	9.99 067	3	**10**	
51	9.31 250	60	9.32 185	63	10.67 815	9.99 064	3	9	
52	9.31 310	60	9.32 248	63	10.67 752	9.99 062	2	8	
53	9.31 370	60	9.32 311	63	10.67 689	9.99 059	3	7	
54	9.31 430	60	9.32 373	62	10.67 627	9.99 056	3	6	
55	9.31 490	59	9.32 436	63	10.67 564	9.99 054	2	5	
56	9.31 549	60	9.32 498	62	10.67 502	9.99 051	3	4	
57	9.31 609	60	9.32 561	63	10.67 439	9.99 048	3	3	
58	9.31 669	59	9.32 623	62	10.67 377	9.99 046	2	2	
59	9.31 728	60	9.32 685	62	10.67 315	9.99 043	3	1	
60	9.31 788		9.32 747		10.67 253	9.99 040	3	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	68	67	66
1	6.8	6.7	6.6
2	13.6	13.4	13.2
3	20.4	20.1	19.8
4	27.2	26.8	26.4
5	34.0	33.5	33.0
6	40.8	40.2	39.6
7	47.6	46.9	46.2
8	54.4	53.6	52.8
9	61.2	60.3	59.4

	65	64	63
1	6.5	6.4	6.3
2	13.0	12.8	12.6
3	19.5	19.2	18.9
4	26.0	25.6	25.2
5	32.5	32.0	31.5
6	39.0	38.4	37.8
7	45.5	44.8	44.1
8	52.0	51.2	50.4
9	58.5	57.6	56.7

	62	61	60
1	6.2	6.1	6.0
2	12.4	12.2	12.0
3	18.6	18.3	18.0
4	24.8	24.4	24.0
5	31.0	30.5	30.0
6	37.2	36.6	36.0
7	43.4	42.7	42.0
8	49.6	48.8	48.0
9	55.8	54.9	54.0

	59	3	2
1	5.9	0.3	0.2
2	11.8	0.6	0.4
3	17.7	0.9	0.6
4	23.6	1.2	0.8
5	29.5	1.5	1.0
6	35.4	1.8	1.2
7	41.3	2.1	1.4
8	47.2	2.4	1.6
9	53.1	2.7	1.8

TABLE II

12°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d	′
0	9.31 788		9.32 747		10.67 253	9.99 040		**60**
		59		63			2	
1	9.31 847		9.32 810		10.67 190	9.99 038		59
		60		62			3	
2	9.31 907		9.32 872		10.67 128	9.99 035		58
		59		61			3	
3	9.31 966		9.32 933		10.67 067	9.99 032		57
		59		62			2	
4	9.32 025		9.32 995		10.67 005	9.99 030	3	56
		59		62				
5	9.32 084		9.33 057		10.66 943	9.99 027	3	55
		59		62				
6	9.32 143		9.33 119		10.66 881	9.99 024		54
		59		61			2	
7	9.32 202		9.33 180		10.66 820	9.99 022	3	53
		59		62				
8	9.32 261		9.33 242		10.66 758	9.99 019	3	52
		58		61				
9	9.32 319		9.33 303		10.66 697	9.99 016	3	51
		59		62				
10	9.32 378		9.33 365		10.66 635	9.99 013		**50**
		59		61			2	
11	9.32 437		9.33 426		10.66 574	9.99 011	3	49
		58		61				
12	9.32 495		9.33 487		10.66 513	9.99 008	3	48
		58		61				
13	9.32 553		9.33 548		10.66 452	9.99 005	3	47
		59		61				
14	9.32 612		9.33 609		10.66 391	9.99 002	3	46
		58		61			2	
15	9.32 670		9.33 670		10.66 330	9.99 000	3	45
		58		61				
16	9.32 728		9.33 731		10.66 269	9.98 997	3	44
		58		61				
17	9.32 786		9.33 792		10.66 208	9.98 994	3	43
		58		61				
18	9.32 844		9.33 853		10.66 147	9.98 991	2	42
		58		60				
19	9.32 902		9.33 913		10.66 087	9.98 989	3	41
		58		61				
20	9.32 960		9.33 974		10.66 026	9.98 986		**40**
		58		60			3	
21	9.33 018		9.34 034		10.65 966	9.98 983	3	39
		57		61				
22	9.33 075		9.34 095		10.65 905	9.98 980	3	38
		58		60				
23	9.33 133		9.34 155		10.65 845	9.98 978	2	37
		57		60				
24	9.33 190		9.34 215		10.65 785	9.98 975	3	36
		58		61				
25	9.33 248		9.34 276		10.65 724	9.98 972	3	35
		57		60				
26	9.33 305		9.34 336		10.65 664	9.98 969	3	34
		57		60				
27	9.33 362		9.34 396		10.65 604	9.98 967	2	33
		58		60				
28	9.33 420		9.34 456		10.65 544	9.98 964	3	32
		57		60				
29	9.33 477		9.34 516		10.65 484	9.98 961	3	31
		57		60				
30	9.33 534		9.34 576		10.65 424	9.98 958	3	**30**
		57		59				
31	9.33 591		9.34 635		10.65 365	9.98 955	3	29
		56		60			2	
32	9.33 647		9.34 695		10.65 305	9.98 953	3	28
		57		60				
33	9.33 704		9.34 755		10.65 245	9.98 950	3	27
		57		59				
34	9.33 761		9.34 814		10.65 186	9.98 947	3	26
		57		60				
35	9.33 818		9.34 874		10.65 126	9.98 944	3	25
		56		59				
36	9.33 874		9.34 933		10.65 067	9.98 941	3	24
		57		59				
37	9.33 931		9.34 992		10.65 008	9.98 938	2	23
		56		59				
38	9.33 987		9.35 051		10.64 949	9.98 936	3	22
		56		60				
39	9.34 043		9.35 111		10.64 889	9.98 933	3	21
		57		59				
40	9.34 100		9.35 170		10.64 830	9.98 930	3	**20**
		56		59				
41	9.34 156		9.35 229		10.64 771	9.98 927	3	19
		56		59				
42	9.34 212		9.35 288		10.64 712	9.98 924	3	18
		56		59				
43	9.34 268		9.35 347		10.64 653	9.98 921	3	17
		56		58				
44	9.34 324		9.35 405		10.64 595	9.98 919	2	16
		56		59				
45	9.34 380		9.35 464		10.64 536	9.98 916	3	15
		56		59				
46	9.34 436		9.35 523		10.64 477	9.98 913	3	14
		55		58				
47	9.34 491		9.35 581		10.64 419	9.98 910	3	13
		56		59				
48	9.34 547		9.35 640		10.64 360	9.98 907	3	12
		55		58				
49	9.34 602		9.35 698		10.64 302	9.98 904	3	11
		56		59				
50	9.34 658		9.35 757		10.64 243	9.98 901	3	**10**
		55		58				
51	9.34 713		9.35 815		10.64 185	9.98 898	2	9
		56		58				
52	9.34 769		9.35 873		10.64 127	9.98 896	3	8
		55		58				
53	9.34 824		9.35 931		10.64 069	9.98 893	3	7
		55		58				
54	9.34 879		9.35 989		10.64 011	9.98 890	3	6
		55		58				
55	9.34 934		9.36 047		10.63 953	9.98 887	3	5
		55		58				
56	9.34 989		9.36 105		10.63 895	9.98 884	3	4
		55		58				
57	9.35 044		9.36 163		10.63 837	9.98 881	3	3
		55		58				
58	9.35 099		9.36 221		10.63 779	9.98 878	3	2
		55		58				
59	9.35 154		9.36 279		10.63 721	9.98 875	3	1
		55		57				
60	9.35 209		9.36 336		10.63 664	9.98 872		**0**
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′

Prop. Pts.

	63	62	61
1	6.3	6.2	6.1
2	12.6	12.4	12.2
3	18.9	18.6	18.3
4	25.2	24.8	24.4
5	31.5	31.0	30.5
6	37.8	37.2	36.6
7	44.1	43.4	42.7
8	50.4	49.6	48.8
9	56.7	55.8	54.9

	60	59	58
1	6.0	5.9	5.8
2	12.0	11.8	11.6
3	18.0	17.7	17.4
4	24.0	23.6	23.2
5	30.0	29.5	29.0
6	36.0	35.4	34.8
7	42.0	41.3	40.6
8	48.0	47.2	46.4
9	54.0	53.1	52.2

	57	56	55
1	5.7	5.6	5.5
2	11.4	11.2	11.0
3	17.1	16.8	16.5
4	22.8	22.4	22.0
5	28.5	28.0	27.5
6	34.2	33.6	33.0
7	39.9	39.2	38.5
8	45.6	44.8	44.0
9	51.3	50.4	49.5

	3	2
1	0.3	0.2
2	0.6	0.4
3	0.9	0.6
4	1.2	0.8
5	1.5	1.0
6	1.8	1.2
7	2.1	1.4
8	2.4	1.6
9	2.7	1.8

Prop. Pts.

77°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.35 209		9.36 336		10.63 664	9.98 872		60	
1	9.35 263	54	9.36 394	58	10.63 606	9.98 869	3	59	
2	9.35 318	55	9.36 452	58	10.63 548	9.98 867	2	58	
3	9.35 373	55	9.36 509	57	10.63 491	9.98 864	3	57	
4	9.35 427	54	9.36 566	57	10.63 434	9.98 861	3	56	
5	9.35 481	54	9.36 624	58	10.63 376	9.98 858	3	55	
6	9.35 536	55	9.36 681	57	10.63 319	9.98 855	3	54	58 57 56
7	9.35 590	54	9.36 738	57	10.63 262	9.98 852	3	53	1 5.8 5.7 5.6
8	9.35 644	54	9.36 795	57	10.63 205	9.98 849	3	52	2 11.6 11.4 11.2
9	9.35 698	54	9.36 852	57	10.63 148	9.98 846	3	51	3 17.4 17.1 16.8
10	9.35 752	54	9.36 909	57	10.63 091	9.98 843	3	50	4 23.2 22.8 22.4
11	9.35 806	54	9.36 966	57	10.63 034	9.98 840	3	49	5 29.0 28.5 28.0
12	9.35 860	54	9.37 023	57	10.62 977	9.98 837	3	48	6 34 8 34.2 33.6
13	9.35 914	54	9.37 080	57	10.62 920	9.98 834	3	47	7 40.6 39.9 39.2
14	9.35 968	54	9.37 137	56	10.62 863	9.98 831	3	46	8 46.4 45.6 44.8
15	9.36 022	53	9.37 193	57	10.62 807	9.98 828	3	45	9 52.2 51.3 50.4
16	9.36 075	54	9.37 250	56	10.62 750	9.98 825	3	44	
17	9.36 129	53	9.37 306	57	10.62 694	9.98 822	3	43	
18	9.36 182	54	9.37 363	56	10.62 637	9.98 819	3	42	
19	9.36 236	53	9.37 419	57	10.62 581	9.98 816	3	41	55 54 53
20	9.36 289	53	9.37 476	56	10.62 524	9.98 813	3	40	1 5.5 5.4 5.3
21	9.36 342	53	9.37 532	56	10.62 468	9.98 810	3	39	2 11.0 10.8 10.6
22	9.36 395	54	9.37 588	56	10.62 412	9.98 807	3	38	3 16.5 16.2 15.9
23	9.36 449	53	9.37 644	56	10.62 356	9.98 804	3	37	4 22.0 21.6 21.2
24	9.36 502	53	9.37 700	56	10.62 300	9.98 801	3	36	5 27.5 27.0 26.5
25	9.36 555	53	9.37 756	56	10.62 244	9.98 798	3	35	6 33.0 32.4 31.8
26	9.36 608	52	9.37 812	56	10.62 188	9.98 795	3	34	7 38.5 37.8 37.1
27	9.36 660	53	9.37 868	56	10.62 132	9.98 792	3	33	8 44.0 43.2 42.4
28	9.36 713	53	9.37 924	56	10.62 076	9.98 789	3	32	9 49.5 48.6 47.7
29	9.36 766	53	9.37 980	55	10.62 020	9.98 786	3	31	
30	9.36 819	52	9.38 035	56	10.61 965	9.98 783	3	30	
31	9.36 871	53	9.38 091	56	10.61 909	9.98 780	3	29	
32	9.36 924	52	9.38 147	55	10.61 853	9.98 777	3	28	
33	9.36 976	52	9.38 202	55	10.61 798	9.98 774	3	27	52 51
34	9.37 028	53	9.38 257	56	10.61 743	9.98 771	3	26	1 5.2 5.1
35	9.37 081	52	9.38 313	55	10.61 687	9.98 768	3	25	2 10.4 10.2
36	9.37 133	52	9.38 368	55	10.61 632	9.98 765	3	24	3 15.6 15.3
37	9.37 185	52	9.38 423	56	10.61 577	9.98 762	3	23	4 20.8 20.4
38	9.37 237	52	9.38 479	55	10.61 521	9.98 759	3	22	5 26.0 25.5
39	9.37 289	52	9.38 534	55	10.61 466	9.98 756	3	21	6 31.2 30.6
40	9.37 341	52	9.38 589	55	10.61 411	9.98 753	3	20	7 36.4 35.7
41	9.37 393	52	9.38 644	55	10.61 356	9.98 750	4	19	8 41.6 40.8
42	9.37 445	52	9.38 699	55	10.61 301	9.98 746	3	18	9 46.8 45.9
43	9.37 497	52	9.38 754	54	10.61 246	9.98 743	3	17	
44	9.37 549	51	9.38 808	55	10.61 192	9.98 740	3	16	
45	9.37 600	52	9.38 863	55	10.61 137	9.98 737	3	15	
46	9.37 652	51	9.38 918	54	10.61 082	9.98 734	3	14	
47	9.37 703	52	9.38 972	55	10.61 028	9.98 731	3	13	4 3 2
48	9.37 755	51	9.39 027	55	10.60 973	9.98 728	3	12	1 0.4 0.3 0.2
49	9.37 806	52	9.39 082	54	10.60 918	9.98 725	3	11	2 0.8 0.6 0.4
50	9.37 858	51	9.39 136	54	10.60 864	9.98 722	3	10	3 1.2 0.9 0.6
51	9.37 909	51	9.39 190	55	10.60 810	9.98 719	4	9	4 1.6 1.2 0.8
52	9.37 960	51	9.39 245	54	10.60 755	9.98 715	3	8	5 2.0 1.5 1.0
53	9.38 011	51	9.39 299	54	10.60 701	9.98 712	3	7	6 2.4 1.8 1.2
54	9.38 062	51	9.39 353	54	10.60 647	9.98 709	3	6	7 2.8 2.1 1.4
55	9.38 113	51	9.39 407	54	10.60 593	9.98 706	3	5	8 3.2 2.4 1.6
56	9.38 164	51	9.39 461	54	10.60 539	9.98 703	3	4	9 3.6 2.7 1.8
57	9.38 215	51	9.39 515	54	10.60 485	9.98 700	3	3	
58	9.38 266	51	9.39 569	54	10.60 431	9.98 697	3	2	
59	9.38 317	51	9.39 623	54	10.60 377	9.98 694	4	1	
60	9.38 368		9.39 677		10.60 323	9.98 690		0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

76°

TABLE II

14°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.38 368		9.39 677		10.60 323	9.98 690		**60**	
		50		54			3		
1	9.38 418		9.39 731		10.60 269	9.98 687		59	
		51		54			3		
2	9.38 469		9.39 785		10.60 215	9.98 684		58	
		50		53			3		
3	9.38 519		9.39 838		10.60 162	9.98 681		57	
		51		54			3		
4	9.38 570		9.39 892		10.60 108	9.98 678		56	
		50		53			3		
5	9.38 620		9.39 945		10.60 055	9.98 675		55	
		50		54			4		
6	9.38 670		9.39 999		10.60 001	9.98 671		54	
		51		53			3		
7	9.38 721		9.40 052		10.59 948	9.98 668		53	
		50		54			3		
8	9.38 771		9.40 106		10.59 894	9.98 665		52	
		50		53			3		
9	9.38 821		9.40 159		10.59 841	9.98 662		51	
		50		53			3		
10	9.38 871		9.40 212		10.59 788	9.98 659		**50**	
		50		54			3		
11	9.38 921		9.40 266		10.59 734	9.98 656		49	
		50		53			4		
12	9.38 971		9.40 319		10.59 681	9.98 652		48	
		50		53			3		
13	9.39 021		9.40 372		10.59 628	9.98 649		47	
		50		53			3		
14	9.39 071		9.40 425		10.59 575	9.98 646		46	
		50		53			3		
15	9.39 121		9.40 478		10.59 522	9.98 643		45	
		49		53			3		
16	9.39 170		9.40 531		10.59 469	9.98 640		44	
		50		53			4		
17	9.39 220		9.40 584		10.59 416	9.98 636		43	
		50		52			3		
18	9.39 270		9.40 636		10.59 364	9.98 633		42	
		49		53			3		
19	9.39 319		9.40 689		10.59 311	9.98 630		41	
		50		53			3		
20	9.39 369		9.40 742		10.59 258	9.98 627		**40**	
		49		53			4		
21	9.39 418		9.40 795		10.59 205	9.98 623		39	
		49		52			3		
22	9.39 467		9.40 847		10.59 153	9.98 620		38	
		50		53			3		
23	9.39 517		9.40 900		10.59 100	9.98 617		37	
		49		52			3		
24	9.39 566		9.40 952		10.59 048	9.98 614		36	
		49		53			4		
25	9.39 615		9.41 005		10.58 995	9.98 610		35	
		49		52			3		
26	9.39 664		9.41 057		10.58 943	9.98 607		34	
		49		52			3		
27	9.39 713		9.41 109		10.58 891	9.98 604		33	
		49		52			3		
28	9.39 762		9.41 161		10.58 839	9.98 601		32	
		49		53			4		
29	9.39 811		9.41 214		10.58 786	9.98 597		31	
		49		52			3		
30	9.39 860		9.41 266		10.58 734	9.98 594		**30**	
		49		52			3		
31	9.39 909		9.41 318		10.58 682	9.98 591		29	
		49		52			3		
32	9.93 958		9.41 370		10.58 630	9.98 588		28	
		48		52			4		
33	9.40 006		9.41 422		10.58 578	9.98 584		27	
		49		52			3		
34	9.40 055		9.41 474		10.58 526	9.98 581		26	
		48		52			3		
35	9.40 103		9.41 526		10.58 474	9.98 578		25	
		49		52			4		
36	9.40 152		9.41 578		10.58 422	9.98 574		24	
		48		51			3		
37	9.40 200		9.41 629		10.58 371	9.98 571		23	
		49		52			3		
38	9.40 249		9.41 681		10.58 319	9.98 568		22	
		48		52			3		
39	9.40 297		9.41 733		10.58 267	9.98 565		21	
		49		51			4		
40	9.40 346		9.41 784		10.58 216	9.98 561		**20**	
		48		52			3		
41	9.40 394		9.41 836		10.58 164	9.98 558		19	
		48		51			3		
42	9.40 442		9.41 887		10.58 113	9.98 555		18	
		48		52			4		
43	9.40 490		9.41 939		10.58 061	9.98 551		17	
		48		51			3		
44	9.40 538		9.41 990		10.58 010	9.98 548		16	
		48		51			3		
45	9.40 586		9.42 041		10.57 959	9.98 545		15	
		48		52			4		
46	9.40 634		9.42 093		10.57 907	9.98 541		14	
		48		51			3		
47	9.40 682		9.42 144		10.57 856	9.98 538		13	
		48		51			3		
48	9.40 730		9.42 195		10.57 805	9.98 535		12	
		48		51			4		
49	9.40 778		9.42 246		10.57 754	9.98 531		11	
		47		51			3		
50	9.40 825		9.42 297		10.57 703	9.98 528		**10**	
		48		51			3		
51	9.40 873		9.42 348		10.57 652	9.98 525		9	
		48		51			4		
52	9.40 921		9.42 399		10.57 601	9.98 521		8	
		47		51			3		
53	9.40 968		9.42 450		10.57 550	9.98 518		7	
		48		51			3		
54	9.41 016		9.42 501		10.57 499	9.98 515		6	
		47		51			4		
55	9.41 063		9.42 552		10.57 448	9.98 511		5	
		48		51			3		
56	9.41 111		9.42 603		10.57 397	9.98 508		4	
		47		50			3		
57	9.41 158		9.42 653		10.57 347	9.98 505		3	
		47		51			4		
58	9.41 205		9.42 704		10.57 296	9.98 501		2	
		47		51			3		
59	9.41 252		9.42 755		10.57 245	9.98 498		1	
		48		50			4		
60	9.41 300		9.42 805		10.57 195	9.98 494		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	54	53	52
1	5.4	5.3	5.2
2	10.8	10.6	10.4
3	16.2	15.9	15.6
4	21.6	21.2	20.8
5	27.0	26.5	26.0
6	32.4	31.8	31.2
7	37.8	37.1	36.4
8	43.2	42.4	41.6
9	48.6	47.7	46.8

	51	50	49
1	5.1	5.0	4.9
2	10.2	10.0	9.8
3	15.3	15.0	14.7
4	20.4	20.0	19.6
5	25.5	25.0	24.5
6	30.6	30.0	29.4
7	35.7	35.0	34.3
8	40.8	40.0	39.2
9	45.9	45.0	44.1

	48	47
1	4.8	4.7
2	9.6	9.4
3	14.4	14.1
4	19.2	18.8
5	24.0	23.5
6	28.8	28.2
7	33.6	32.9
8	38.4	37.6
9	43.2	42.3

	4	3
1	0.4	0.3
2	0.8	0.6
3	1.2	0.9
4	1.6	1.2
5	2.0	1.5
6	2.4	1.8
7	2.8	2.1
8	3.2	2.4
9	3.6	2.7

75°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.41 300		9.42 805		10.57 195	9.98 494		60	
1	9.41 347	47	9.42 856	51	10.57 144	9.98 491	3	59	
2	9.41 394	47	9.42 906	50	10.57 094	9.98 488	3	58	
3	9.41 441	47	9.42 957	51	10.57 043	9.98 484	4	57	
4	9.41 488	47	9.43 007	50	10.56 993	9.98 481	3	56	
5	9.41 535	47	9.43 057	50	10.56 943	9.98 477	4	55	
6	9.41 582	47	9.43 108	51	10.56 892	9.98 474	3	54	
7	9.41 628	46	9.43 158	50	10.56 842	9.98 471	3	53	
8	9.41 675	47	9.43 208	50	10.56 792	9.98 467	4	52	
9	9.41 722	47	9.43 258	50	10.56 742	9.98 464	3	51	
10	9.41 768	46	9.43 308	50	10.56 692	9.98 460	4	50	
11	9.41 815	47	9.43 358	50	10.56 642	9.98 457	3	49	
12	9.41 861	46	9.43 408	50	10.56 592	9.98 453	4	48	
13	9.41 908	47	9.43 458	50	10.56 542	9.98 450	3	47	
14	9.41 954	46	9.43 508	50	10.56 492	9.98 447	3	46	
15	9.42 001	47	9.43 558	50	10.56 442	9.98 443	4	45	
16	9.42 047	46	9.43 607	49	10.56 393	9.98 440	3	44	
17	9.42 093	46	9.43 657	50	10.56 343	9.98 436	4	43	
18	9.42 140	47	9.43 707	50	10.56 293	9.98 433	3	42	
19	9.42 186	46	9.43 756	49	10.56 244	9.98 429	4	41	
20	9.42 232	46	9.43 806	50	10.56 194	9.98 426	3	40	
21	9.42 278	46	9.43 855	49	10.56 145	9.98 422	4	39	
22	9.42 324	46	9.43 905	50	10.56 095	9.98 419	3	38	
23	9.42 370	46	9.43 954	49	10.56 046	9.98 415	4	37	
24	9.42 416	46	9.44 004	50	10.55 996	9.98 412	3	36	
25	9.42 461	45	9.44 053	49	10.55 947	9.98 409	3	35	
26	9.42 507	46	9.44 102	49	10.55 898	9.98 405	4	34	
27	9.42 553	46	9.44 151	49	10.55 849	9.98 402	3	33	
28	9.42 599	46	9.44 201	50	10.55 799	9.98 398	4	32	
29	9.42 644	45	9.44 250	49	10.55 750	9.98 395	3	31	
30	9.42 690	46	9.44 299	49	10.55 701	9.98 391	4	30	
31	9.42 735	45	9.44 348	49	10.55 652	9.98 388	3	29	
32	9.42 781	46	9.44 397	49	10.55 603	9.98 384	4	28	
33	9.42 826	45	9.44 446	49	10.55 554	9.98 381	3	27	
34	9.42 872	46	9.44 495	49	10.55 505	9.98 377	4	26	
35	9.42 917	45	9.44 544	49	10.55 456	9.98 373	4	25	
36	9.42 962	45	9.44 592	48	10.55 408	9.98 370	3	24	
37	9.43 008	46	9.44 641	49	10.55 359	9.98 366	4	23	
38	9.43 053	45	9.44 690	49	10.55 310	9.98 363	3	22	
39	9.43 098	45	9.44 738	48	10.55 262	9.98 359	4	21	
40	9.43 143	45	9.44 787	49	10.55 213	9.98 356	3	20	
41	9.43. 188	45	9.44 836	49	10.55 164	9.98 352	4	19	
42	9.43 233	45	9.44 884	48	10.55 116	9.98 349	3	18	
43	9.43 278	45	9.44 933	49	10.55 067	9.98 345	4	17	
44	9.43 323	44	9.44 981	48	10.55 019	9.98 342	3	16	
45	9.43 367	45	9.45 029	48	10.54 971	9.98 338	4	15	
46	9.43 412	45	9.45 078	49	10.54 922	9.98 334	4	14	
47	9.43 457	45	9.45 126	48	10.54 874	9.98 331	3	13	
48	9.43 502	44	9.45 174	48	10.54 826	9.98 327	4	12	
49	9.43 546	45	9.45 222	48	10.54 778	9.98 324	3	11	
50	9.43 591	44	9.45 271	49	10.54 729	9.98 320	4	10	
51	9.43 635	45	9.45 319	48	10.54 681	9.98 317	3	9	
52	9.43 680	44	9.45 367	48	10.54 633	9.98 313	4	8	
53	9.43 724	45	9.45 415	48	10.54 585	9.98 309	4	7	
54	9.43 769	44	9.45 463	48	10.54 537	9.98 306	3	6	
55	9.43 813	44	9.45 511	48	10.54 489	9.98 302	4	5	
56	9.43 857	44	9.45 559	48	10.54 441	9.98 299	3	4	
57	9.43 901	45	9.45 606	47	10.54 394	9.98 295	4	3	
58	9.43 946	44	9.45 654	48	10.54 346	9.98 291	4	2	
59	9.43 990	44	9.45 702	48	10.54 298	9.98 288	3	1	
60	9.44 034		9.45 750		10.54 250	9.98 284	4	0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	51	50	49
1	5.1	5.0	4.9
2	10.2	10.0	9.8
3	15.3	15.0	14.7
4	20.4	20.0	19.6
5	25.5	25.0	24.5
6	30.6	30.0	29.4
7	35.7	35.0	34.3
8	40.8	40.0	39.2
9	45.9	45.0	44.1

	48	47	46
1	4.8	4.7	4.6
2	9.6	9.4	9.2
3	14.4	14.1	13.8
4	19.2	18.8	18.4
5	24.0	23.5	23.0
6	28.8	28.2	27.6
7	33.6	32.9	32.2
8	38.4	37.6	36.8
9	43.2	42.3	41.4

	45	44
1	4.5	4.4
2	9.0	8.8
3	13.5	13.2
4	18.0	17.6
5	22.5	22.0
6	27.0	26.4
7	31.5	30.8
8	36.0	35.2
9	40.5	39.6

	4	3
1	0.4	0.3
2	0.8	0.6
3	1.2	0.9
4	1.6	1.2
5	2.0	1.5
6	2.4	1.8
7	2.8	2.1
8	3.2	2.4
9	3.6	2.7

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.44 034		9.45 750		10.54 250	9.98 284		60	
1	9.44 078	44	9.45 797	47	10.54 203	9.98 281	3	59	
2	9.44 122	44	9.45 845	48	10.54 155	9.98 277	4	58	
3	9.44 166	44	9.45 892	47	10.54 108	9.98 273	4	57	
4	9.44 210	44	9.45 940	48	10.54 060	9.98 270	3	56	
5	9.44 253	43	9.45 987	47	10.54 013	9.98 266	4	55	
6	9.44 297	44	9.46 035	48	10.53 965	9.98 262	4	54	
7	9.44 341	44	9.46 082	47	10.53 918	9.98 259	3	53	
8	9.44 385	44	9.46 130	48	10.53 870	9.98 255	4	52	
9	9.44 428	43	9.46 177	47	10.53 823	9.98 251	4	51	
10	9.44 472	44	9.46 224	47	10.53 776	9.98 248	3	50	
11	9.44 516	44	9.46 271	47	10.53 729	9.98 244	4	49	
12	9.44 559	43	9.46 319	48	10.53 681	9.98 240	4	48	
13	9.44 602	43	9.46 366	47	10.53 634	9.98 237	3	47	
14	9.44 646	44	9.46 413	47	10.53 587	9.98 233	4	46	
15	9.44 689	43	9.46 460	47	10.53 540	9.98 229	4	45	
16	9.44 733	44	9.46 507	47	10.53 493	9.98 226	3	44	
17	9.44 776	43	9.46 554	47	10.53 446	9.98 222	4	43	
18	9.44 819	43	9.46 601	47	10.53 399	9.98 218	4	42	
19	9.44 862	43	9.46 648	47	10.53 352	9.98 215	3	41	
20	9.44 905	43	9.46 694	46	10.53 306	9.98 211	4	40	
21	9.44 948	43	9.46 741	47	10.53 259	9.98 207	4	39	
22	9.44 992	44	9.46 788	47	10.53 212	9.98 204	3	38	
23	9.45 035	43	9.46 835	47	10.53 165	9.98 200	4	37	
24	9.45 077	42	9.46 881	46	10.53 119	9.98 196	4	36	
25	9.45 120	43	9.46 928	47	10.53 072	9.98 192	4	35	
26	9.45 163	43	9.46 975	47	10.53 025	9.98 189	3	34	
27	9.45 206	43	9.47 021	46	10.52 979	9.98 185	4	33	
28	9.45 249	43	9.47 068	47	10.52 932	9.98 181	4	32	
29	9.45 292	42	9.47 114	46	10.52 886	9.98 177	4	31	
30	9.45 334	43	9.47 160	46	10.52 840	9.98 174	3	30	
31	9.45 377	42	9.47 207	47	10.52 793	9.98 170	4	29	
32	9.45 419	43	9.47 253	46	10.52 747	9.98 166	4	28	
33	9.45 462	42	9.47 299	46	10.52 701	9.98 162	4	27	
34	9.45 504	43	9.47 346	47	10.52 654	9.98 159	3	26	
35	9.45 547	42	9.47 392	46	10.52 608	9.98 155	4	25	
36	9.45 589	43	9.47 438	46	10.52 562	9.98 151	4	24	
37	9.45 632	42	9.47 484	46	10.52 516	9.98 147	4	23	
38	9.45 674	42	9.47 530	46	10.52 470	9.98 144	3	22	
39	9.45 716	42	9.47 576	46	10.52 424	9.98 140	4	21	
40	9.45 758	43	9.47 622	46	10.52 378	9.98 136	4	20	
41	9.45 801	42	9.47 668	46	10.52 332	9.98 132	4	19	
42	9.45 843	42	9.47 714	46	10.52 286	9.98 129	3	18	
43	9.45 885	42	9.47 760	46	10.52 240	9.98 125	4	17	
44	9.45 927	42	9.47 806	46	10.52 194	9.98 121	4	16	
45	9.45 969	42	9.47 852	45	10.52 148	9.98 117	4	15	
46	9.46 011	42	9.47 897	46	10.52 103	9.98 113	4	14	
47	9.46 053	42	9.47 943	46	10.52 057	9.98 110	3	13	
48	9.46 095	41	9.47 989	46	10.52 011	9.98 106	4	12	
49	9.46 136	42	9.48 035	45	10.51 965	9.98 102	4	11	
50	9.46 178	42	9.48 080	46	10.51 920	9.98 098	4	10	
51	9.46 220	42	9.48 126	45	10.51 874	9.98 094	4	9	
52	9.46 262	41	9.48 171	46	10.51 829	9.98 090	3	8	
53	9.46 303	42	9.48 217	45	10.51 783	9.98 087	4	7	
54	9.46 345	41	9.48 262	45	10.51 738	9.98 083	4	6	
55	9.46 386	42	9.48 307	46	10.51 693	9.98 079	4	5	
56	9.46 428	41	9.48 353	45	10.51 647	9.98 075	4	4	
57	9.46 469	42	9.48 398	45	10.51 602	9.98 071	4	3	
58	9.46 511	41	9.48 443	46	10.51 557	9.98 067	4	2	
59	9.46 552	42	9.48 489	45	10.51 511	9.98 063	3	1	
60	9.46 594		9.48 534		10.51 466	9.98 060		0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

′	48	47	46
1	4.8	4.7	4.6
2	9.6	9.4	9.2
3	14.4	14.1	13.8
4	19.2	18.8	18.4
5	24.0	23.5	23.0
6	28.8	28.2	27.6
7	33.6	32.9	32.2
8	38.4	37.6	36.8
9	43.2	42.3	41.4

′	45	44	43
1	4.5	4.4	4.3
2	9.0	8.8	8.6
3	13.5	13.2	12.9
4	18.0	17.6	17.2
5	22.5	22.0	21.5
6	27.0	26.4	25.8
7	31.5	30.8	30.1
8	36.0	35.2	34.4
9	40.5	39.6	38.7

′	42	41
1	4.2	4.1
2	8.4	8.2
3	12.6	12.3
4	16.8	16.4
5	21.0	20.5
6	25.2	24.6
7	29.4	28.7
8	33.6	32.8
9	37.8	36.9

′	4	3
1	0.4	0.3
2	0.8	0.6
3	1.2	0.9
4	1.6	1.2
5	2.0	1.5
6	2.4	1.8
7	2.8	2.1
8	3.2	2.4
9	3.6	2.7

′	L Sin	d	L Tan	c d	L Cot	L Cos	d	′
0	9.46 594		9.48 534		10.51 466	9.98 060		60
1	9.46 635	41	9.48 579	45	10.51 421	9.98 056	4	59
2	9.46 676	41	9.48 624	45	10.51 376	9.98 052	4	58
3	9.46 717	41	9.48 669	45	10.51 331	9.98 048	4	57
4	9.46 758	41	9.48 714	45	10.51 286	9.98 044	4	56
5	9.46 800	42	9.48 759	45	10.51 241	9.98 040	4	55
6	9.46 841	41	9.48 804	45	10.51 196	9.98 036	4	54
7	9.46 882	41	9.48 849	45	10.51 151	9.98 032	4	53
8	9.46 923	41	9.48 894	45	10.51 106	9.98 029	3	52
9	9.46 964	41	9.48 939	45	10.51 061	9.98 025	4	51
10	9.47 005	40	9.48 984	45	10.51 016	9.98 021	4	50
11	9.47 045	41	9.49 029	44	10.50 971	9.98 017	4	49
12	9.47 086	41	9.49 073	45	10.50 927	9.98 013	4	48
13	9.47 127	41	9.49 118	45	10.50 882	9.98 009	4	47
14	9.47 168	41	9.49 163	44	10.50 837	9.98 005	4	46
15	9.47 209	40	9.49 207	45	10.50 793	9.98 001	4	45
16	9.47 249	41	9.49 252	44	10.50 748	9.97 997	4	44
17	9.47 290	40	9.49 296	45	10.50 704	9.97 993	4	43
18	9.47 330	41	9.49 341	44	10.50 659	9.97 989	3	42
19	9.47 371	40	9.49 385	45	10.50 615	9.97 986	4	41
20	9.47 411	41	9.49 430	44	10.50 570	9.97 982	4	40
21	9.47 452	40	9.49 474	45	10.50 526	9.97 978	4	39
22	9.47 492	41	9.49 519	44	10.50 481	9.97 974	4	38
23	9.47 533	40	9.49 563	44	10.50 437	9.97 970	4	37
24	9.47 573	40	9.49 607	45	10.50 393	9.97 966	4	36
25	9.47 613	41	9.49 652	44	10.50 348	9.97 962	4	35
26	9.47 654	40	9.49 696	44	10.50 304	9.97 958	4	34
27	9.47 694	40	9.49 740	44	10.50 260	9.97 954	4	33
28	9.47 734	40	9.49 784	44	10.50 216	9.97 950	4	32
29	9.47 774	40	9.49 828	44	10.50 172	9.97 946	4	31
30	9.47 814	40	9.49 872	44	10.50 128	9.97 942	4	30
31	9.47 854	40	9.49 916	44	10.50 084	9.97 938	4	29
32	9.47 894	40	9.49 960	44	10.50 040	9.97 934	4	28
33	9.47 934	40	9.50 004	44	10.49 996	9.97 930	4	27
34	9.47 974	40	9.50 048	44	10.49 952	9.97 926	4	26
35	9.48 014	40	9.50 092	44	10.49 908	9.97 922	4	25
36	9.48 054	40	9.50 136	44	10.49 864	9.97 918	4	24
37	9.48 094	39	9.50 180	43	10.49 820	9.97 914	4	23
38	9.48 133	40	9.50 223	44	10.49 777	9.97 910	4	22
39	9.48 173	40	9.50 267	44	10.49 733	9.97 906	4	21
40	9.48 213	39	9.50 311	44	10.49 689	9.97 902	4	20
41	9.48 252	40	9.50 355	43	10.49 645	9.97 898	4	19
42	9.48 292	40	9.50 398	44	10.49 602	9.97 894	4	18
43	9.48 332	39	9.50 442	44	10.49 558	9.97 890	4	17
44	9.48 371	40	9.50 485	43	10.49 515	9.97 886	4	16
45	9.48 411	39	9.50 529	43	10.49 471	9.97 882	4	15
46	9.48 450	40	9.50 572	44	10.49 428	9.97 878	4	14
47	9.48 490	39	9.50 616	43	10.49 384	9.97 874	4	13
48	9.48 529	39	9.50 659	44	10.49 341	9.97 870	4	12
49	9.48 568	39	9.50 703	43	10.49 297	9.97 866	5	11
50	9.48 607	40	9.50 746	43	10.49 254	9.97 861	4	10
51	9.48 647	39	9.50 789	44	10.49 211	9.97 857	4	9
52	9.48 686	39	9.50 833	43	10.49 167	9.97 853	4	8
53	9.48 725	39	9.50 876	43	10.49 124	9.97 849	4	7
54	9.48 764	39	9.50 919	43	10.49 081	9.97 845	4	6
55	9.48 803	39	9.50 962	43	10.49 038	9.97 841	4	5
56	9.48 842	39	9.51 005	43	10.48 995	9.97 837	4	4
57	9.48 881	39	9.51 048	44	10.48 952	9.97 833	4	3
58	9.48 920	39	9.51 092	43	10.48 908	9.97 829	4	2
59	9.48 959	39	9.51 135	43	10.48 865	9.97 825	4	1
60	9.48 998		9.51 178		10.48 822	9.97 821		0
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′

Prop. Pts.

	45	44	43
1	4.5	4.4	4.3
2	9.0	8.8	8.6
3	13.5	13.2	12.9
4	18.0	17.6	17.2
5	22.5	22.0	21.5
6	27.0	26.4	25.8
7	31.5	30.8	30.1
8	36.0	35.2	34.4
9	40.5	39.6	38.7

	42	41
1	4.2	4.1
2	8.4	8.2
3	12.6	12.3
4	16.8	16.4
5	21.0	20.5
6	25.2	24.6
7	29.4	28.7
8	33.6	32.8
9	37.8	36.9

	40	39
1	4.0	3.9
2	8.0	7.8
3	12.0	11.7
4	16.0	15.6
5	20.0	19.5
6	24.0	23.4
7	28.0	27.3
8	32.0	31.2
9	36.0	35.1

	5	4	3
1	0.5	0.4	0.3
2	1.0	0.8	0.6
3	1.5	1.2	0.9
4	2.0	1.6	1.2
5	2.5	2.0	1.5
6	3.0	2.4	1.8
7	3.5	2.8	2.1
8	4.0	3.2	2.4
9	4.5	3.6	2.7

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.48 998		9.51 178		10.48 822	9.97 821		**60**	
1	9.49 037	39	9.51 221	43	10.48 779	9.97 817	4	59	
2	9.49 076	39	9.51 264	43	10.48 736	9.97 812	5	58	
3	9.49 115	39	9.51 306	42	10.48 694	9.97 808	4	57	
4	9.49 153	38	9.51 349	43	10.48 651	9.97 804	4	56	
5	9.49 192	39	9.51 392	43	10.48 608	9.97 800	4	55	
6	9.49 231	39	9.51 435	43	10.48 565	9.97 796	4	54	
7	9.49 269	38	9.51 478	42	10.48 522	9.97 792	4	53	
8	9.49 308	39	9.51 520	43	10.48 480	9.97 788	4	52	
9	9.49 347	39	9.51 563	43	10.48 437	9.97 784	5	51	
10	9.49 385	38	9.51 606	42	10.48 394	9.97 779	4	**50**	
11	9.49 424	39	9.51 648	43	10.48 352	9.97 775	4	49	
12	9.49 462	38	9.51 691	43	10.48 309	9.97 771	4	48	
13	9.49 500	38	9.51 734	42	10.48 266	9.97 767	4	47	
14	9.49 539	39	9.51 776	43	10.48 224	9.97 763	4	46	
15	9.49 577	38	9.51 819	42	10.48 181	9.97 759	5	45	
16	9.49 615	38	9.51 861	42	10.48 139	9.97 754	4	44	
17	9.49 654	39	9.51 903	43	10.48 097	9.97 750	4	43	
18	9.49 692	38	9.51 946	42	10.48 054	9.97 746	4	42	
19	9.49 730	38	9.51 988	43	10.48 012	9.97 742	4	41	
20	9.49 768	38	9.52 031	42	10.47 969	9.97 738	4	**40**	
21	9.49 806	38	9.52 073	42	10.47 927	9.97 734	5	39	
22	9.49 844	38	9.52 115	42	10.47 885	9.97 729	4	38	
23	9.49 882	38	9.52 157	42	10.47 843	9.97 725	4	37	
24	9.49 920	38	9.52 200	43	10.47 800	9.97 721	4	36	
25	9.49 958	38	9.52 242	42	10.47 758	9.97 717	4	35	
26	9.49 996	38	9.52 284	42	10.47 716	9.97 713	4	34	
27	9.50 034	38	9.52 326	42	10.47 674	9.97 708	5	33	
28	9.50 072	38	9.52 368	42	10.47 632	9.97 704	4	32	
29	9.50 110	38	9.52 410	42	10.47 590	9.97 700	4	31	
30	9.50 148	37	9.52 452	42	10.47 548	9.97 696	4	**30**	
31	9.50 185	38	9.52 494	42	10.47 506	9.97 691	5	29	
32	9.50 223	38	9.52 536	42	10.47 464	9.97 687	4	28	
33	9.50 261	37	9.52 578	42	10.47 422	9.97 683	4	27	
34	9.50 298	38	9.52 620	41	10.47 380	9.97 679	4	26	
35	9.50 336	38	9.52 661	42	10.47 339	9.97 674	5	25	
36	9.50 374	37	9.52 703	42	10.47 297	9.97 670	4	24	
37	9.50 411	38	9.52 745	42	10.47 255	9.97 666	4	23	
38	9.50 449	37	9.52 787	42	10.47 213	9.97 662	4	22	
39	9.50 486	37	9.52 829	41	10.47 171	9.97 657	5	21	
40	9.50 523	38	9.52 870	42	10.47 130	9.97 653	4	**20**	
41	9.50 561	37	9.52 912	41	10.47 088	9.97 649	4	19	
42	9.50 598	37	9.52 953	42	10.47 047	9.97 645	4	18	
43	9.50 635	38	9.52 995	42	10.47 005	9.97 640	5	17	
44	9.50 673	37	9.53 037	41	10.46 963	9.97 636	4	16	
45	9.50 710	37	9.53 078	42	10.46 922	9.97 632	4	15	
46	9.50 747	37	9.53 120	41	10.46 880	9.97 628	4	14	
47	9.50 784	37	9.53 161	41	10.46 839	9.97 623	5	13	
48	9.50 821	37	9.53 202	42	10.46 798	9.97 619	4	12	
49	9.50 858	38	9.53 244	41	10.46 756	9.97 615	4	11	
50	9.50 896	37	9.53 285	42	10.46 715	9.97 610	5	**10**	
51	9.50 933	37	9.53 327	41	10.46 673	9.97 606	4	9	
52	9.50 970	37	9.53 368	41	10.46 632	9.97 602	4	8	
53	9.51 007	36	9.53 409	41	10.46 591	9.97 597	5	7	
54	9.51 043	37	9.53 450	42	10.46 550	9.97 593	4	6	
55	9.51 080	37	9.53 492	41	10.46 508	9.97 589	4	5	
56	9.51 117	37	9.53 533	41	10.46 467	9.97 584	5	4	
57	9.51 154	37	9.53 574	41	10.46 426	9.97 580	4	3	
58	9.51 191	36	9.53 615	41	10.46 385	9.97 576	4	2	
59	9.51 227	37	9.53 656	41	10.46 344	9.97 571	5	1	
60	9.51 264		9.53 697		10.46 303	9.97 567	4	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	43	42	41
1	4.3	4.2	4.1
2	8.6	8.4	8.2
3	12.9	12.6	12.3
4	17.2	16.8	16.4
5	21.5	21.0	20.5
6	25.8	25.2	24.6
7	30.1	29.4	28.7
8	34.4	33.6	32.8
9	38.7	37.8	36.9

	39	38	37
1	3.9	3.8	3.7
2	7.8	7.6	7.4
3	11.7	11.4	11.1
4	15.6	15.2	14.8
5	19.5	19.0	18.5
6	23.4	22.8	22.2
7	27.3	26.6	25.9
8	31.2	30.4	29.6
9	35.1	34.2	33.3

	36	5	4
1	3.6	0.5	0.4
2	7.2	1.0	0.8
3	10.8	1.5	1.2
4	14.4	2.0	1.6
5	18.0	2.5	2.0
6	21.6	3.0	2.4
7	25.2	3.5	2.8
8	28.8	4.0	3.2
9	32.4	4.5	3.6

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.51 264		9.53 697		10.46 303	9.97 567		**60**	
1	9.51 301	37	9.53 738	41	10.46 262	9.97 563	4	59	
2	9.51 338	37	9.53 779	41	10.46 221	9.97 558	5	58	
3	9.51 374	36	9.53 820	41	10.46 180	9.97 554	4	57	
4	9.51 411	37	9.53 861	41	10.46 139	9.97 550	4	56	
5	9.51 447	36	9.53 902	41	10.46 098	9.97 545	5	55	
6	9.51 484	37	9.53 943	41	10.46 057	9.97 541	4	54	
7	9.51 520	36	9.53 984	41	10.46 016	9.97 536	5	53	
8	9.51 557	37	9.54 025	41	10.45 975	9.97 532	4	52	
9	9.51 593	36	9.54 065	40	10.45 935	9.97 528	4	51	
10	9.51 629	36	9.54 106	41	10.45 894	9.97 523	5	**50**	
11	9.51 666	37	9.54 147	41	10.45 853	9.97 519	4	49	
12	9.51 702	36	9.54 187	40	10.45 813	9.97 515	4	48	
13	9.51 738	36	9.54 228	41	10.45 772	9.97 510	5	47	
14	9.51 774	36	9.54 269	41	10.45 731	9.97 506	4	46	
15	9.51 811	37	9.54 309	40	10.45 691	9.97 501	5	45	
16	9.51 847	36	9.54 350	41	10.45 650	9.97 497	4	44	
17	9.51 883	36	9.54 390	40	10.45 610	9.97 492	5	43	
18	9.51 919	36	9.54 431	41	10.45 569	9.97 488	4	42	
19	9.51 955	36	9.54 471	40	10.45 529	9.97 484	4	41	
20	9.51 991	36	9.54 512	41	10.45 488	9.97 479	5	**40**	
21	9.52 027	36	9.54 552	40	10.45 448	9.97 475	4	39	
22	9.52 063	36	9.54 593	41	10.45 407	9.97 470	5	38	
23	9.52 099	36	9.54 633	40	10.45 367	9.97 466	4	37	
24	9.52 135	36	9.54 673	40	10.45 327	9.97 461	5	36	
25	9.52 171	36	9.54 714	41	10.45 286	9.97 457	4	35	
26	9.52 207	35	9.54 754	40	10.45 246	9.97 453	4	34	
27	9.52 242	36	9.54 794	40	10.45 206	9.97 448	5	33	
28	9.52 278	36	9.54 835	41	10.45 165	9.97 444	4	32	
29	9.52 314	36	9.54 875	40	10.45 125	9.97 439	5	31	
30	9.52 350	35	9.54 915	40	10.45 085	9.97 435	4	**30**	
31	9.52 385	36	9.54 955	40	10.45 045	9.97 430	5	29	
32	9.52 421	35	9.54 995	40	10.45 005	9.97 426	4	28	
33	9.52 456	36	9.55 035	40	10.44 965	9.97 421	5	27	
34	9.52 492	35	9.55 075	40	10.44 925	9.97 417	4	26	
35	9.52 527	36	9.55 115	40	10.44 885	9.97 412	5	25	
36	9.52 563	35	9.55 155	40	10.44 845	9.97 408	4	24	
37	9.52 598	36	9.55 195	40	10.44 805	9.97 403	5	23	
38	9.52 634	35	9.55 235	40	10.44 765	9.97 399	4	22	
39	9.52 669	36	9.55 275	40	10.44 725	9.97 394	5	21	
40	9.52 705	35	9.55 315	40	10.44 685	9.97 390	4	**20**	
41	9.52 740	35	9.55 355	40	10.44 645	9.97 385	5	19	
42	9.52 775	36	9.55 395	39	10.44 605	9.97 381	4	18	
43	9.52 811	35	9.55 434	40	10.44 566	9.97 376	5	17	
44	9.52 846	35	9.55 474	40	10.44 526	9.97 372	4	16	
45	9.52 881	35	9.55 514	40	10.44 486	9.97 367	5	15	
46	9.52 916	35	9.55 554	39	10.44 446	9.97 363	4	14	
47	9.52 951	35	9.55 593	40	10.44 407	9.97 358	5	13	
48	9.52 986	35	9.55 633	40	10.44 367	9.97 353	5	12	
49	9.53 021	35	9.55 673	39	10.44 327	9.97 349	4	11	
50	9.53 056	36	9.55 712	40	10.44 288	9.97 344	5	**10**	
51	9.53 092	34	9.55 752	39	10.44 248	9.97 340	4	9	
52	9.53 126	35	9.55 791	40	10.44 209	9.97 335	5	8	
53	9.53 161	35	9.55 831	39	10.44 169	9.97 331	4	7	
54	9.53 196	35	9.55 870	40	10.44 130	9.97 326	5	6	
55	9.53 231	35	9.55 910	39	10.44 090	9.97 322	5	5	
56	9.53 266	35	9.55 949	40	10.44 051	9.97 317	5	4	
57	9.53 301	35	9.55 989	39	10.44 011	9.97 312	5	3	
58	9.53 336	34	9.56 028	39	10.43 972	9.97 308	4	2	
59	9.53 370	35	9.56 067	40	10.43 933	9.97 303	5	1	
60	9.53 405		9.56 107		10.43 893	9.97 299	4	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	41	40	39
1	4.1	4.0	3.9
2	8.2	8.0	7.8
3	12.3	12.0	11.7
4	16.4	16.0	15.6
5	20.5	20.0	19.5
6	24.6	24.0	23.4
7	28.7	28.0	27.3
8	32.8	32.0	31.2
9	36.9	36.0	35.1

	37	36	35
1	3.7	3.6	3.5
2	7.4	7.2	7.0
3	11.1	10.8	10.5
4	14.8	14.4	14.0
5	18.5	18.0	17.5
6	22.2	21.6	21.0
7	25.9	25.2	24.5
8	29.6	28.8	28.0
9	33.3	32.4	31.5

	34	5	4
1	3.4	0.5	0.4
2	6.8	1.0	0.8
3	10.2	1.5	1.2
4	13.6	2.0	1.6
5	17.0	2.5	2.0
6	20.4	3.0	2.4
7	23.8	3.5	2.8
8	27.2	4.0	3.2
9	30.6	4.5	3.6

TABLE II

20°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.53 405		9.56 107		10.43 893	9.97 299		**60**	
1	9.53 440	35	9.56 146	39	10.43 854	9.97 294	5	59	
2	9.53 475	35	9.56 185	39	10.43 815	9.97 289	5	58	
3	9.53 509	34	9.56 224	39	10.43 776	9.97 285	4	57	
4	9.53 544	35	9.56 264	40	10.43 736	9.97 280	5	56	
5	9.53 578	34	9.56 303	39	10.43 697	9.97 276	4	55	
6	9.53 613	35	9.56 342	39	10.43 658	9.97 271	5	54	
7	9.53 647	34	9.56 381	39	10.43 619	9.97 266	5	53	
8	9.53 682	35	9.56 420	39	10.43 580	9.97 262	4	52	
9	9.53 716	34	9.56 459	39	10.43 541	9.97 257	5	51	
10	9.53 751	35	9.56 498		10.43 502	9.97 252	5	**50**	
11	9.53 785	34	9.56 537	39	10.43 463	9.97 248	4	49	
12	9.53 819	34	9.56 576	39	10.43 424	9.97 243	5	48	
13	9.53 854	35	9.56 615	39	10.43 385	9.97 238	5	47	
14	9.53 888	34	9.56 654	39	10.43 346	9.97 234	4	46	
15	9.53 922	34	9.56 693	39	10.43 307	9.97 229	5	45	
16	9.53 957	35	9.56 732	39	10.43 268	9.97 224	5	44	
17	9.53 991	34	9.56 771	39	10.43 229	9.97 220	4	43	
18	9.54 025	34	9.56 810	39	10.43 190	9.97 215	5	42	
19	9.54 059	34	9.56 849	38	10.43 151	9.97 210	5	41	
20	9.54 093	34	9.56 887	39	10.43 113	9.97 206	4	**40**	
21	9.54 127	34	9.56 926	39	10.43 074	9.97 201	5	39	
22	9.54 161	34	9.56 965	39	10.43 035	9.97 196	5	38	
23	9.54 195	34	9.57 004	38	10.42 996	9.97 192	4	37	
24	9.54 229	34	9.57 042	39	10.42 958	9.97 187	5	36	
25	9.54 263	34	9.57 081	39	10.42 919	9.97 182	5	35	
26	9.54 297	34	9.57 120	39	10.42 880	9.97 178	4	34	
27	9.54 331	34	9.57 158	38	10.42 842	9.97 173	5	33	
28	9.54.365	34	9.57 197	39	10.42 803	9.97 168	5	32	
29	9.54 399	34	9.57 235	38	10.42 765	9.97 163	5	31	
30	9.54 433	33	9.57 274	39	10.42 726	9.97 159	4	**30**	
31	9.54 466	34	9.57 312	38	10.42 688	9.97 154	5	29	
32	9.54 500	34	9.57 351	39	10.42 649	9.97 149	5	28	
33	9.54 534	33	9.57 389	38	10.42 611	9.97 145	4	27	
34	9.54 567	34	9.57 428	39	10.42 572	9.97 140	5	26	
35	9.54 601	34	9.57 466	38	10.42 534	9.97 135	5	25	
36	9.54 635	33	9.57 504	38	10.42 496	9.97 130	5	24	
37	9.54 668	34	9.57 543	39	10.42 457	9.97 126	4	23	
38	9.54 702	33	9.57 581	38	10.42 419	9.97 121	5	22	
39	9.54 735	34	9.57 619	38	10.42 381	9.97 116	5	21	
40	9.54 769	33	9.57 658	39	10.42 342	9.97 111	5	**20**	
41	9.54 802	34	9.57 696	38	10.42 304	9.97 107	4	19	
42	9.54 836	33	9.57 734	38	10.42 266	9.97 102	5	18	
43	9.54 869	34	9.57 772	38	10.42 228	9.97 097	5	17	
44	9.54 903	33	9.57 810	39	10.42 190	9.97 092	5	16	
45	9.54 936	33	9.57 849	38	10.42 151	9.97 087	4	15	
46	9.54 969	34	9.57 887	38	10.42 113	9.97 083	5	14	
47	9.55 003	33	9.57 925	38	10.42 075	9.97 078	5	13	
48	9.55 036	33	9.57 963	38	10.42 037	9.97 073	5	12	
49	9.55 069	33	9.58 001	38	10.41 999	9.97 068	5	11	
50	9.55 102	34	9.58 039	38	10.41 961	9.97 063	4	**10**	
51	9.55 136	33	9.58 077	38	10.41 923	9.97 059	5	9	
52	9.55 169	33	9.58 115	38	10.41 885	9.97 054	5	8	
53	9.55 202	33	9.58 153	38	10.41 847	9.97 049	5	7	
54	9.55 235	33	9.58 191	38	10.41 809	9.97 044	5	6	
55	9.55 268	33	9.58 229	38	10.41 771	9.97 039	4	5	
56	9.55 301	33	9.58 267	37	10.41 733	9.97 035	5	4	
57	9.55 334	33	9.58 304	38	10.41 696	9.97 030	5	3	
58	9.55 367	33	9.58 342	38	10.41 658	9.97 025	5	2	
59	9.55 400	33	9.58 380	38	10.41 620	9.97 020	5	1	
60	9.55 433		9.58 418		10.41 582	9.97 015		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	40	39	38
1	4.0	3.9	3.8
2	8.0	7.8	7.6
3	12.0	11.7	11.4
4	16.0	15.6	15.2
5	20.0	19.5	19.0
6	24.0	23.4	22.8
7	28.0	27.3	26.6
8	32.0	31.2	30.4
9	36.0	35.1	34.2

	37	35	34
1	3.7	3.5	3.4
2	7.4	7.0	6.8
3	11.1	10.5	10.2
4	14.8	14.0	13.6
5	18.5	17.5	17.0
6	22.2	21.0	20.4
7	25.9	24.5	23.8
8	29.6	28.0	27.2
9	33.3	31.5	30.6

	33	5	4
1	3.3	0.5	0.4
2	6.6	1.0	0.8
3	9.9	1.5	1.2
4	13.2	2.0	1.6
5	16.5	2.5	2.0
6	19.8	3.0	2.4
7	23.1	3.5	2.8
8	26.4	4.0	3.2
9	29.7	4.5	3.6

69°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.55 433		9.58 418		10.41 582	9.97 015		**60**	
1	9.55 466	33	9.58 455	37	10.41 545	9.97 010	5	59	
2	9.55 499	33	9.58 493	38	10.41 507	9.97 005	5	58	
3	9.55 532	33	9.58 531	38	10.41 469	9.97 001	4	57	
4	9.55 564	32	9.58 569	37	10.41 431	9.96 996	5	56	
5	9.55 597	33	9.58 606	38	10.41 394	9.96 991	5	55	
6	9.55 630	33	9.58 644	37	10.41 356	9.96 986	5	54	
7	9.55 663	33	9.58 681	38	10.41 319	9.96 981	5	53	
8	9.55 695	32	9.58 719	38	10.41 281	9.96 976	5	52	
9	9.55 728	33	9.58 757	37	10.41 243	9.96 971	5	51	
10	9.55 761	33	9.58 794		10.41 206	9.96 966	5	**50**	
11	9.55 793	32	9.58 832	38	10.41 168	9.96 962	4	49	
12	9.55 826	33	9.58 869	37	10.41 131	9.96 957	5	48	
13	9.55 858	32	9.58 907	38	10.41 093	9.96 952	5	47	
14	9.55 891	33	9.58 944	37	10.41 056	9.96 947	5	46	
15	9.55 923	32	9.58 981	37	10.41 019	9.96 942	5	45	
16	9.55 956	33	9.59 019	38	10.40 981	9.96 937	5	44	
17	9.55 988	32	9.59 056	37	10.40 944	9.96 932	5	43	
18	9.56 021	33	9.59 094	38	10.40 906	9.96 927	5	42	
19	9.56 053	32	9.59 131	37	10.40 869	9.96 922	5	41	
20	9.56 085	32	9.59 168	37	10.40 832	9.96 917	5	**40**	
21	9.56 118	33	9.59 205	38	10.40 795	9.96 912	5	39	
22	9.56 150	32	9.59 243	37	10.40 757	9.96 907	5	38	
23	9.56 182	32	9.59 280	37	10.40 720	9.96 903	4	37	
24	9.56 215	33	9.59 317	37	10.40 683	9.96 898	5	36	
25	9.56 247	32	9.59 354	37	10.40 646	9.96 893	5	35	
26	9.56 279	32	9.59 391	38	10.40 609	9.96 888	5	34	
27	9.56 311	32	9.59 429	37	10.40 571	9.96 883	5	33	
28	9.56 343	32	9.59 466	37	10.40 534	9.96 878	5	32	
29	9.56 375	33	9.59 503	37	10.40 497	9.96 873	5	31	
30	9.56 408	32	9.59 540	37	10.40 460	9.96 868	5	**30**	
31	9.56 440	32	9.59 577	37	10.40 423	9.96 863	5	29	
32	9.56 472	32	9.59 614	37	10.40 386	9.96 858	5	28	
33	9.56 504	32	9.59 651	37	10.40 349	9.96 853	5	27	
34	9.56 536	32	9.59 688	37	10.40 312	9.96 848	5	26	
35	9.56 568	31	9.59 725	37	10.40 275	9.96 843	5	25	
36	9.56 599	32	9.59 762	37	10.40 238	9.96 838	5	24	
37	9.56 631	32	9.59 799	36	10.40 201	9.96 833	5	23	
38	9.56 663	32	9.59 835	37	10.40 165	9.96 828	5	22	
39	9.56 695	32	9.59 872	37	10.40 128	9.96 823	5	21	
40	9.56 727	32	9.59 909	37	10.40 091	9.96 818	5	**20**	
41	9.56 759	31	9.59 946	37	10.40 054	9.96 813	5	19	
42	9.56 790	32	9.59 983	36	10.40 017	9.96 808	5	18	
43	9.56 822	32	9.60 019	37	10.39 981	9.96 803	5	17	
44	9.56 854	32	9.60 056	37	10.39 944	9.96 798	5	16	
45	9.56 886	31	9.60 093	37	10.39 907	9.96 793	5	15	
46	9.56 917	32	9.60 130	36	10.39 870	9.96 788	5	14	
47	9.56 949	31	9.60 166	37	10.39 834	9.96 783	5	13	
48	9.56 980	32	9.60 203	37	10.39 797	9.96 778	6	12	
49	9.57 012	32	9.60 240	36	10.39 760	9.96 772	5	11	
50	9.57 044	31	9.60 276	37	10.39 724	9.96 767	5	**10**	
51	9.57 075	32	9.60 313	36	10.39 687	9.96 762	5	9	
52	9.57 107	31	9.60 349	37	10.39 651	9.96 757	5	8	
53	9.57 138	31	9.60 386	36	10.39 614	9.96 752	5	7	
54	9.57 169	32	9.60 422	37	10.39 578	9.96 747	5	6	
55	9.57 201	31	9.60 459	36	10.39 541	9.96 742	5	5	
56	9.57 232	32	9.60 495	37	10.39 505	9.96 737	5	4	
57	9.57 264	31	9.60 532	36	10.39 468	9.96 732	5	3	
58	9.57 295	31	9.60 568	37	10.39 432	9.96 727	5	2	
59	9.57 326	32	9.60 605	36	10.39 395	9.96 722	5	1	
60	9.57 358		9.60 641		10.39 359	9.96 717		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	38	37	36
1	3.8	3.7	3.6
2	7.6	7.4	7.2
3	11.4	11.1	10.8
4	15.2	14.8	14.4
5	19.0	18.5	18.0
6	22.8	22.2	21.6
7	26.6	25.9	25.2
8	30.4	29.6	28.8
9	34.2	33.3	32.4

	33	32	31
1	3.3	3.2	3.1
2	6.6	6.4	6.2
3	9.9	9.6	9.3
4	13.2	12.8	12.4
5	16.5	16.0	15.5
6	19.8	19.2	18.6
7	23.1	22.4	21.7
8	26.4	25.6	24.8
9	29.7	28.8	27.9

	6	5	4
1	0.6	0.5	0.4
2	1.2	1.0	0.8
3	1.8	1.5	1.2
4	2.4	2.0	1.6
5	3.0	2.5	2.0
6	3.6	3.0	2.4
7	4.2	3.5	2.8
8	4.8	4.0	3.2
9	5.4	4.5	3.6

TABLE II

22°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.57 358		9.60 641		10.39 359	9.96 717		**60**	
1	9.57 389	31	9.60 677	36	10.39 323	9.96 711	6	59	
2	9.57 420	31	9.60 714	37	10.39 286	9.96 706	5	58	
3	9.57 451	31	9.60 750	36	10.39 250	9.96 701	5	57	
4	9.57 482	31	9.60 786	36	10.39 214	9.96 696	5	56	
5	9.57 514	32	9.60 823	37	10.39 177	9.96 691	5	55	
6	9.57 545	31	9.60 859	36	10.39 141	9.96 686	5	54	
7	9.57 576	31	9.60 895	36	10.39 105	9.96 681	5	53	
8	9.57 607	31	9.60 931	36	10.39 069	9.96 676	5	52	
9	9.57 638	31	9.60 967	36	10.39 033	9.96 670	6	51	
10	9.57 669	31	9.61 004	37	10.38 996	9.96 665	5	**50**	
11	9.57 700	31	9.61 040	36	10.38 960	9.96 660	5	49	
12	9.57 731	31	9.61 076	36	10.38 924	9.96 655	5	48	
13	9.57 762	31	9.61 112	36	10.38 888	9.96 650	5	47	
14	9.57 793	31	9.61 148	36	10.38 852	9.96 645	5	46	
15	9.57 824	31	9.61 184	36	10.38 816	9.96 640	5	45	
16	9.57 855	30	9.61 220	36	10.38 780	9.96 634	6	44	
17	9.57 885	31	9.61 256	36	10.38 744	9.96 629	5	43	
18	9.57 916	31	9.61 292	36	10.38 708	9.96 624	5	42	
19	9.57 947	31	9.61 328	36	10.38 672	9.96 619	5	41	
20	9.57 978	30	9.61 364	36	10.38 636	9.96 614	6	**40**	
21	9.58 008	31	9.61 400	36	10.38 600	9.96 608	5	39	
22	9.58 039	31	9.61 436	36	10.38 564	9.96 603	5	38	
23	9.58 070	31	9.61 472	36	10.38 528	9.96 598	5	37	
24	9.58 101	30	9.61 508	36	10.38 492	9.96 593	5	36	
25	9.58 131	31	9.61 544	35	10.38 456	9.96 588	6	35	
26	9.58 162	30	9.61 579	36	10.38 421	9.96 582	5	34	
27	9.58 192	31	9.61 615	36	10.38 385	9.96 577	5	33	
28	9.58 223	30	9.61 651	36	10.38 349	9.96 572	5	32	
29	9.58 253	31	9.61 687	35	10.38 313	9.96 567	5	31	
30	9.58 284	30	9.61 722	36	10.38 278	9.96 562	6	**30**	
31	9.58 314	31	9.61 758	36	10.38 242	9.96 556	5	29	
32	9.58 345	30	9.61 794	36	10.38 206	9.96 551	5	28	
33	9.58 375	31	9.61 830	35	10.38 170	9.96 546	5	27	
34	9.58 406	30	9.61 865	36	10.38 135	9.96 541	6	26	
35	9.58 436	31	9.61 901	35	10.38 099	9.96 535	5	25	
36	9.58 467	30	9.61 936	36	10.38 064	9.96 530	5	24	
37	9.58 497	30	9.61 972	36	10.38 028	9.96 525	5	23	
38	9.58 527	30	9.62 008	35	10.37 992	9.96 520	6	22	
39	9.58 557	31	9.62 043	36	10.37 957	9.96 514	5	21	
40	9.58 588	30	9.62 079	35	10.37 921	9.96 509	5	**20**	
41	9.58 618	30	9.62 114	36	10.37 886	9.96 504	6	19	
42	9.58 648	30	9.62 150	35	10.37 850	9.96 498	5	18	
43	9.58 678	31	9.62 185	36	10.37 815	9.96 493	5	17	
44	9.58 709	30	9.62 221	35	10.37 779	9.96 488	5	16	
45	9.58 739	30	9.62 256	36	10.37 744	9.96 483	6	15	
46	9.58 769	30	9.62 292	35	10.37 708	9.96 477	5	14	
47	9.58 799	30	9.62 327	35	10.37 673	9.96 472	5	13	
48	9.58 829	30	9.62 362	36	10.37 638	9.96 467	6	12	
49	9.58 859	30	9.62 398	35	10.37 602	9.96 461	5	11	
50	9.58 889	30	9.62 433	35	10.37 567	9.96 456	5	**10**	
51	9.58 919	30	9.62 468	36	10.37 532	9.96 451	6	9	
52	9.58 949	30	9.62 504	35	10.37 496	9.96 445	5	8	
53	9.58 979	30	9.62 539	35	10.37 461	9.96 440	5	7	
54	9.59 009	30	9.62 574	35	10.37 426	9.96 435	6	6	
55	9.59 039	30	9.62 609	36	10.37 391	9.96 429	5	5	
56	9.59 069	29	9.62 645	35	10.37 355	9.96 424	5	4	
57	9.59 098	30	9.62 680	35	10.37 320	9.96 419	6	3	
58	9.59 128	30	9.62 715	35	10.37 285	9.96 413	5	2	
59	9.59 158	30	9.62 750	35	10.37 250	9.96 408	5	1	
60	9.59 188		9.62 785		10.37 215	9.96 403		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	37	36	35
1	3.7	3.6	3.5
2	7.4	7.2	7.0
3	11.1	10.8	10.5
4	14.8	14.4	14.0
5	18.5	18.0	17.5
6	22.2	21.6	21.0
7	25.9	25.2	24.5
8	29.6	28.8	28.0
9	33.3	32.4	31.5

	32	31	30
1	3.2	3.1	3.0
2	6.4	6.2	6.0
3	9.6	9.3	9.0
4	12.8	12.4	12.0
5	16.0	15.5	15.0
6	19.2	18.6	18.0
7	22.4	21.7	21.0
8	25.6	24.8	24.0
9	28.8	27.9	27.0

	29	6	5
1	2.9	0.6	0.5
2	5.8	1.2	1.0
3	8.7	1.8	1.5
4	11.6	2.4	2.0
5	14.5	3.0	2.5
6	17.4	3.6	3.0
7	20.3	4.2	3.5
8	23.2	4.8	4.0
9	26.1	5.4	4.5

67°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.59 188		9.62 785		10.37 215	9.96 403		**60**	
1	9.59 218	30	9.62 820	35	10.37 180	9.96 397	6	59	
2	9.59 247	29	9.62 855	35	10.37 145	9.96 392	5	58	
3	9.59 277	30	9.62 890	35	10.37 110	9.96 387	5	57	
4	9.59 307	30	9.62 926	36	10.37 074	9.96 381	6	56	
5	9.59 336	29	9.62 961	35	10.37 039	9.96 376	5	55	
6	9.59 366	30	9.62 996	35	10.37 004	9.96 370	6	54	
7	9.59 396	30	9.63 031	35	10.36 969	9.96 365	5	53	
8	9.59 425	29	9.63 066	35	10.36 934	9.96 360	5	52	
9	9.59 455	30	9.63 101	35	10.36 899	9.96 354	6	51	
10	9.59 484	29	9.63 135	34	10.36 865	9.96 349	5	**50**	
11	9.59 514	30	9.63 170	35	10.36 830	9.96 343	6	49	
12	9.59 543	29	9.63 205	35	10.36 795	9.96 338	5	48	
13	9.59 573	30	9.63 240	35	10.36 760	9.96 333	5	47	
14	9.59 602	29	9.63 275	35	10.36 725	9.96 327	6	46	
15	9.59 632	30	9.63 310	35	10.36 690	9.96 322	5	45	
16	9.59 661	29	9.63 345	35	10.36 655	9.96 316	6	44	
17	9.59 690	29	9.63 379	34	10.36 621	9.96 311	5	43	
18	9.59 720	30	9.63 414	35	10.36 586	9.96 305	6	42	
19	9.59 749	29	9.63 449	35	10.36 551	9.96 300	5	41	
20	9.59 778	29	9.63 484	35	10.36 516	9.96 294	6	**40**	
21	9.59 808	30	9.63 519	34	10.36 481	9.96 289	5	39	
22	9.59 839	29	9.63 553	35	10.36 447	9.96 284	5	38	
23	9.59 866	29	9.63 588	35	10.36 412	9.96 278	6	37	
24	9.59 895	29	9.63 623	34	10.36 377	9.96 273	5	36	
25	9.59 924	29	9.63 657	35	10.36 343	9.96 267	6	35	
26	9.59 954	30	9.63 692	34	10.36 308	9.96 262	5	34	
27	9.59 983	29	9.63 726	35	10.36 274	9.96 256	6	33	
28	9.60 012	29	9.63 761	35	10.36 239	9.96 251	5	32	
29	9.60 041	29	9.63 796	34	10.36 204	9.96 245	6	31	
30	9.60 070	29	9.63 830	35	10.36 170	9.96 240	5	**30**	
31	9.60 099	29	9.63 865	34	10.36 135	9.96 234	6	29	
32	9.60 128	29	9.63 899	35	10.36 101	9.96 229	5	28	
33	9.60 157	29	9.63 934	34	10.36 066	9.96 223	6	27	
34	9.60 186	29	9.63 968	35	10.36 032	9.96 218	5	26	
35	9.60 215	29	9.64 003	34	10.35 997	9.96 212	6	25	
36	9.60 244	29	9.64 037	35	10.35 963	9.96 207	5	24	
37	9.60 273	29	9.64 072	34	10.35 928	9.96 201	6	23	
38	9.60 302	29	9.64 106	34	10.35 894	9.96 196	5	22	
39	9.60 331	28	9.64 140	35	10.35 860	9.96 190	6	21	
40	9.60 359	29	9.64 175	34	10.35 825	9.96 185	5	**20**	
41	9.60 388	29	9.64 209	34	10.35 791	9.96 179	6	19	
42	9.60 417	29	9.64 243	35	10.35 757	9.96 174	5	18	
43	9.60 446	28	9.64 278	34	10.35 722	9.96 168	6	17	
44	9.60 474	29	9.64 312	34	10.35 688	9.96 162	6	16	
45	9.60 503	29	9.64 346	35	10.35 654	9.96 157	5	15	
46	9.60 532	29	9.64 381	34	10.35 619	9.96 151	6	14	
47	9.60 561	28	9.64 415	34	10.35 585	9.96 146	5	13	
48	9.60 589	29	9.64 449	34	10.35 551	9.96 140	6	12	
49	9.60 618	28	9.64 483	34	10.35 517	9.96 135	5	11	
50	9.60 646	29	9.64 517	35	10.35 483	9.96 129	6	**10**	
51	9.60 675	29	9.64 552	34	10.35 448	9.96 123	6	9	
52	9.60 704	28	9.64 586	34	10.35 414	9.96 118	5	8	
53	9.60 732	29	9.64 620	34	10.35 380	9.96 112	6	7	
54	9.60 761	28	9.64 654	34	10.35 346	9.96 107	5	6	
55	9.60 789	29	9.64 688	34	10.35 312	9.96 101	6	5	
56	9.60 818	28	9.64 722	34	10.35 278	9.96 095	6	4	
57	9.60 846	29	9.64 756	34	10.35 244	9.96 090	5	3	
58	9.60 875	28	9.64 790	34	10.35 210	9.96 084	6	2	
59	9.60 903	28	9.64 824	34	10.35 176	9.96 079	5	1	
60	9.60 931		9.64 858		10.35 142	9.96 073	6	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	35	35	34
1	3.6	3.5	3.4
2	7.2	7.0	6.8
3	10.8	10.5	10.2
4	14.4	14.0	13.6
5	18.0	17.5	17.0
6	21.6	21.0	20.4
7	25.2	24.5	23.8
8	28.8	28.0	27.2
9	32.4	31.5	30.6

	30	29	28
1	3.0	2.9	2.8
2	6.0	5.8	5.6
3	9.0	8.7	8.4
4	12.0	11.6	11.2
5	15.0	14.5	14.0
6	18.0	17.4	16.8
7	21.0	20.3	19.6
8	24.0	23.2	22.4
9	27.0	26.1	25.2

	6	5
1	0.6	0.5
2	1.2	1.0
3	1.8	1.5
4	2.4	2.0
5	3.0	2.5
6	3.6	3.0
7	4.2	3.5
8	4.8	4.0
9	5.4	4.5

TABLE II

24°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.60 931		9.64 858		10.35 142	9.96 073		**60**	
1	9.60 960	29	9.64 892	34	10.35 108	9.96 067	6	59	
2	9.60 988	28	9.64 926	34	10.35 074	9.96 062	5	58	
3	9.61 016	28	9.64 960	34	10.35 040	9.96 056	6	57	
4	9.61 045	29	9.64 994	34	10.35 006	9.96 050	6	56	
5	9.61 073	28	9.65 028	34	10.34 972	9.96 045	5	55	
6	9.61 101	28	9.65 062	34	10.34 938	9.96 039	6	54	
7	9.61 129	28	9.65 096	34	10.34 904	9.96 034	5	53	
8	9.61 158	29	9.65 130	34	10.34 870	9.96 028	6	52	
9	9.61 186	28	9.65 164	33	10.34 836	9.96 022	6	51	
10	9.61 214	28	9.65 197	34	10.34 803	9.96 017	5	**50**	
11	9.61 242	28	9.65 231	34	10.34 769	9.96 011	6	49	
12	9.61 270	28	9.65 265	34	10.34 735	9.96 005	6	48	
13	9.61 298	28	9.65 299	34	10.34 701	9.96 000	5	47	
14	9.61 326	28	9.65 333	33	10.34 667	9.95 994	6	46	
15	9.61 354	28	9.65 366	34	10.34 634	9.95 988	6	45	
16	9.61 382	28	9.65 400	34	10.34 600	9.95 982	6	44	
17	9.61 411	29	9.65 434	33	10.34 566	9.95 977	5	43	
18	9.61 438	27	9.65 467	34	10.34 533	9.95 971	6	42	
19	9.61 466	28	9.65 501	34	10.34 499	9.95 965	6	41	
20	9.61 494	28	9.65 535	33	10.34 465	9.95 960	5	**40**	
21	9.61 522	28	9.65 568	34	10.34 432	9.95 954	6	39	
22	9.61 550	28	9.65 602	34	10.34 398	9.95 948	6	38	
23	9.61 578	28	9.65 636	33	10.34 364	9.95 942	6	37	
24	9.61 606	28	9.65 669	34	10.34 331	9.95 937	5	36	
25	9.61 634	28	9.65 703	33	10.34 297	9.95 931	6	35	
26	9.61 662	27	9.65 736	34	10.34 264	9.95 925	6	34	
27	9.61 689	28	9.65 770	33	10.34 230	9.95 920	5	33	
28	9.61 717	28	9.65 803	34	10.34 197	9.95 914	6	32	
29	9.61 745	28	9.65 837	33	10.34 163	9.95 908	6	31	
30	9.61 773	27	9.65 870	34	10.34 130	9.95 902	6	**30**	
31	9.61 800	28	9.65 904	33	10.34 096	9.95 897	5	29	
32	9.61 828	28	9.65 937	34	10.34 063	9.95 891	6	28	
33	9.61 856	27	9.65 971	33	10.34 029	9.95 885	6	27	
34	9.61 883	28	9.66 004	34	10.33 996	9.95 879	6	26	
35	9.61 911	28	9.66 038	33	10.33 962	9.95 873	6	25	
36	9.61 939	27	9.66 071	33	10.33 929	9.95 868	5	24	
37	9.61 966	28	9.66 104	34	10.33 896	9.95 862	6	23	
38	9.61 994	27	9.66 138	33	10.33 862	9.95 856	6	22	
39	9.62 021	28	9.66 171	33	10.33 829	9.95 850	6	21	
40	9.62 049	27	9.66 204	34	10.33 796	9.95 844	6	**20**	
41	9.62 076	28	9.66 238	33	10.33 762	9.95 839	5	19	
42	9.62 104	27	9.66 271	33	10.33 729	9.95 833	6	18	
43	9.62 131	28	9.66 304	33	10.33 696	9.95 827	6	17	
44	9.62 159	27	9.66 337	34	10.33 663	9.95 821	6	16	
45	9.62 186	28	9.66 371	33	10.33 629	9.95 815	6	15	
46	9.62 214	27	9.66 404	33	10.33 596	9.95 810	5	14	
47	9.62 241	27	9.66 437	33	10.33 563	9.95 804	6	13	
48	9.62 268	28	9.66 470	33	10.33 530	9.95 798	6	12	
49	9.62 296	27	9.66 503	34	10.33 497	9.95 792	6	11	
50	9.62 323	27	9.66 537	33	10.33 463	9.95 786	6	**10**	
51	9.62 350	27	9.66 570	33	10.33 430	9.95 780	5	9	
52	9.62 377	28	9.66 603	33	10.33 397	9.95 775	6	8	
53	9.62 405	27	9.66 636	33	10.33 364	9.95 769	6	7	
54	9.62 432	27	9.66 669	33	10.33 331	9.95 763	6	6	
55	9.62 459	27	9.66 702	33	10.33 298	9.95 757	6	5	
56	9.62 486	27	9.66 735	33	10.33 265	9.95 751	6	4	
57	9.62 513	28	9.66 768	33	10.33 232	9.95 745	6	3	
58	9.62 541	27	9.66 801	33	10.33 199	9.95 739	6	2	
59	9.62 568	27	9.66 834	33	10.33 166	9.95 733	5	1	
60	9.62 595		9.66 867		10.33 133	9.95 728		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	34	33
1	3.4	3.3
2	6.8	6.6
3	10.2	9.9
4	13.6	13.2
5	17.0	16.5
6	20.4	19.8
7	23.8	23.1
8	27.2	26.4
9	30.6	29.7

	29	28	27
1	2.9	2.8	2.7
2	5.8	5.6	5.4
3	8.7	8.4	8.1
4	11.6	11.2	10.8
5	14.5	14.0	13.5
6	17.4	16.8	16.2
7	20.3	19.6	18.9
8	23.2	22.4	21.6
9	26.1	25.2	24.3

	6	5
1	0.6	0.5
2	1.2	1.0
3	1.8	1.5
4	2.4	2.0
5	3.0	2.5
6	3.6	3.0
7	4.2	3.5
8	4.8	4.0
9	5.4	4.5

65°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d	′	Prop. Pts.
0	9.62 595		9.66 867		10.33 133	9.95 728		**60**	
1	9.62 622	27	9.66 900	33	10.33 100	9.95 722	6	59	
2	9.62 649	27	9.66 933	33	10.33 067	9.95 716	6	58	
3	9.62 676	27	9.66 966	33	10.33 034	9.95 710	6	57	
4	9.62 703	27	9.66 999	33	10.33 001	9.95 704	6	56	
5	9.62 730	27	9.67 032	33	10.32 968	9.95 698	6	55	
6	9.62 757	27	9.67 065	33	10.32 935	9.95 692	6	54	
7	9.62 784	27	9.67 098	33	10.32 902	9.95 686	6	53	
8	9.62 811	27	9.67 131	32	10.32 869	9.95 680	6	52	
9	9.62 838	27	9.67 163	33	10.32 837	9.95 674	6	51	
10	9.62 865	27	9.67 196	33	10.32 804	9.95 668	6	**50**	
11	9.62 892	26	9.67 229	33	10.32 771	9.95 663	5	49	
12	9.62 918	27	9.67 262	33	10.32 738	9.95 657	6	48	
13	9.62 945	27	9.67 295	32	10.32 705	9.95 651	6	47	
14	9.62 972	27	9.67 327	33	10.32 673	9.95 645	6	46	
15	9.62 999	27	9.67 360	33	10.32 640	9.95 639	6	45	
16	9.63 026	26	9.67 393	33	10.32 607	9.95 633	6	44	
17	9.63 052	27	9.67 426	32	10.32 574	9.95 627	6	43	
18	9.63 079	27	9.67 458	33	10.32 542	9.95 621	6	42	
19	9.63 106	27	9.67 491	33	10.32 509	9.95 615	6	41	
20	9.63 133	26	9.67 524	32	10.32 476	9.95 609	6	**40**	
21	9.63 159	27	9.67 556	33	10.32 444	9.95 603	6	39	
22	9.63 186	27	9.67 589	33	10.32 411	9.95 597	6	38	
23	9.63 213	26	9.67 622	32	10.32 378	9.95 591	6	37	
24	9.63 239	27	9.67 654	33	10.32 346	9.95 585	6	36	
25	9.63 266	26	9.67 687	32	10.32 313	9.95 579	6	35	
26	9.63 292	27	9.67 719	33	10.32 281	9.95 573	6	34	
27	9.63 319	26	9.67 752	33	10.32 248	9.95 567	6	33	
28	9.63 345	27	9.67 785	32	10.32 215	9.95 561	6	32	
29	9.63 372	26	9.67 817	33	10.32 183	9.95 555	6	31	
30	9.63 398	27	9.67 850	32	10.32 150	9.95 549	6	**30**	
31	9.63 425	26	9.67 882	33	10.32 118	9.95 543	6	29	
32	9.63 451	27	9.67 915	32	10.32 085	9.95 537	6	28	
33	9.63 478	26	9.67 947	33	10.32 053	9.95 531	6	27	
34	9.63 504	27	9.67 980	32	10.32 020	9.95 525	6	26	
35	9.63 531	26	9.68 012	32	10.31 988	9.95 519	6	25	
36	9.63 557	26	9.68 044	32	10.31 956	9.95 513	6	24	
37	9.63 583	27	9.68 077	33	10.31 923	9.95 507	6	23	
38	9.63 610	26	9.68 109	32	10.31 891	9.95 500	7	22	
39	9.63 636	26	9.68 142	33	10.31 858	9.95 494	6	21	
40	9.63 662	27	9.68 174	32	10.31 826	9.95 488	6	**20**	
41	9.63 689	26	9.68 206	32	10.31 794	9.95 482	6	19	
42	9.63 715	26	9.68 239	33	10.31 761	9.95 476	6	18	
43	9.63 741	26	9.68 271	32	10.31 729	9.95 470	6	17	
44	9.63 767	27	9.68 303	33	10.31 697	9.95 464	6	16	
45	9.63 794	26	9.68 336	32	10.31 664	9.95 458	6	15	
46	9.63 820	26	9.68 368	32	10.31 632	9.95 452	6	14	
47	9.63 846	26	9.68 400	32	10.31 600	9.95 446	6	13	
48	9.63 872	26	9.68 432	33	10.31 568	9.95 440	6	12	
49	9.63 898	26	9.68 465	32	10.31 535	9.95 434	7	11	
50	9.63 924	26	9.68 497	32	10.31 503	9.95 427	6	**10**	
51	9.63 950	26	9.68 529	32	10.31 471	9.95 421	6	9	
52	9.63 976	26	9.68 561	32	10.31 439	9.95 415	6	8	
53	9.64 002	26	9.68 593	33	10.31 407	9.95 409	6	7	
54	9.64 028	26	9.68 626	32	10.31 374	9.95 403	6	6	
55	9.64 054	26	9.68 658	32	10.31 342	9.95 397	6	5	
56	9.64 080	26	9.68 690	32	10.31 310	9.95 391	7	4	
57	9.64 106	26	9.68 722	32	10.31 278	9.95 384	6	3	
58	9.64 132	26	9.68 754	32	10.31 246	9.95 378	6	2	
59	9.64 158	26	9.68 786	32	10.31 214	9.95 372	6	1	
60	9.64 184		9.68 818		10.31 182	9.95 366		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	33	32
1	3.3	3.2
2	6.6	6.4
3	9.9	9.6
4	13.2	12.8
5	16.5	16.0
6	19.8	19.2
7	23.1	22.4
8	26.4	25.6
9	29.7	28.8

	27	26
1	2.7	2.6
2	5.4	5.2
3	8.1	7.8
4	10.8	10.4
5	13.5	13.0
6	16.2	15.6
7	18.9	18.2
8	21.6	20.8
9	24.3	23.4

	7	6	5
1	0.7	0.6	0.5
2	1.4	1.2	1.0
3	2.1	1.8	1.5
4	2.8	2.4	2.0
5	3.5	3.0	2.5
6	4.2	3.6	3.0
7	4.9	4.2	3.5
8	5.6	4.8	4.0
9	6.3	5.4	4.5

TABLE II

26°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.64 184		9.68 818		10.31 182	9.95 366		**60**	
1	9.64 210	26	9.68 850	32	10.31 150	9.95 360	6	59	
2	9.64 236	26	9.68 882	32	10.31 118	9.95 354	6	58	
3	9.64 262	26	9.68 914	32	10.31 086	9.95 348	6	57	
4	9.64 288	26	9.68 946	32	10.31 054	9.95 341	7	56	
5	9.64 313	25	9.68 978	32	10.31 022	9.95 335	6	55	
6	9.64 339	26	9.69 010	32	10.30 990	9.95 329	6	54	
7	9.64 365	26	9.69 042	32	10.30 958	9.95 323	6	53	
8	9.64 391	26	9.69 074	32	10.30 926	9.95 317	6	52	
9	9.64 417	25	9.69 106	32	10.30 894	9.95 310	7	51	
10	9.64 442	26	9.69 138	32	10.30 862	9.95 304	6	**50**	
11	9.64 468	26	9.69 170	32	10.30 830	9.95 298	6	49	
12	9.64 494	25	9.69 202	32	10.30 798	9.95 292	6	48	
13	9.64 519	26	9.69 234	32	10.30 766	9.95 286	6	47	
14	9.64 545	26	9.69 266	32	10.30 734	9.95 279	7	46	
15	9.64 571	25	9.69 298	31	10.30 702	9.95 273	6	45	
16	9.64 596	26	9.69 329	32	10.30 671	9.95 267	6	44	
17	9.64 622	25	9.69 361	32	10.30 639	9.95 261	6	43	
18	9.64 647	26	9.69 393	32	10.30 607	9.95 254	7	42	
19	9.64 673	25	9.69 425	32	10.30 575	9.95 248	6	41	
20	9.64 698	26	9.69 457	31	10.30 543	9.95 242	6	**40**	
21	9.64 724	25	9.69 488	32	10.30 512	9.95 236	6	39	
22	9.64 749	26	9.69 520	32	10.30 480	9.95 229	7	38	
23	9.64 775	25	9.69 552	32	10.30 448	9.95 223	6	37	
24	9.64 800	26	9.69 584	31	10.30 416	9.95 217	6	36	
25	9.64 826	25	9.69 615	32	10.30 385	9.95 211	6	35	
26	9.64 851	26	9.69 647	32	10.30 353	9.95 204	7	34	
27	9.64 877	25	9.69 679	31	10.30 321	9.95 198	6	33	
28	9.64 902	25	9.69 710	32	10.30 290	9.95 192	6	32	
29	9.64 927	26	9.69 742	32	10.30 258	9.95 185	7	31	
30	9.64 953	25	9.69 774	31	10.30 226	9.95 179	6	**30**	
31	9.64 978	25	9.69 805	32	10.30 195	9.95 173	6	29	
32	9.65 003	26	9.69 837	31	10.30 163	9.95 167	6	28	
33	9.65 029	25	9.69 868	32	10.30 132	9.95 160	7	27	
34	9.65 054	25	9.69 900	32	10.30 100	9.95 154	6	26	
35	9.65 079	25	9.69 932	31	10.30 068	9.95 148	6	25	
36	9.65 104	26	9.69 963	32	10.30 037	9.95 141	7	24	
37	9.65 130	25	9.69 995	31	10.30 005	9.95 135	6	23	
38	9.65 155	25	9.70 026	32	10.29 974	9.95 129	6	22	
39	9.65 180	25	9.70 058	31	10.29 942	9.95 122	7	21	
40	9.65 205	25	9.70 089	32	10.29 911	9.95 116	6	**20**	
41	9.65 230	25	9.70 121	31	10.29 879	9.95 110	6	19	
42	9.65 255	26	9.70 152	32	10.29 848	9.95 103	7	18	
43	9.65 281	25	9.70 184	31	10.29 816	9.95 097	6	17	
44	9.65 306	25	9.70 215	32	10.29 785	9.95 090	7	16	
45	9.65 331	25	9.70 247	31	10.29 753	9.95 084	6	15	
46	9.65 356	25	9.70 278	31	10.29 722	9.95 078	6	14	
47	9.65 381	25	9.70 309	32	10.29 691	9.95 071	7	13	
48	9.65 406	25	9.70 341	31	10.29 659	9.95 065	6	12	
49	9.65 431	25	9.70 372	32	10.29 628	9.95 059	6	11	
50	9.65 456	25	9.70 404	31	10.29 596	9.95 052	7	**10**	
51	9.65 481	25	9.70 435	31	10.29 565	9.95 046	6	9	
52	9.65 506	25	9.70 466	32	10.29 534	9.95 039	7	8	
53	9.65 531	25	9.70 498	31	10.29 502	9.95 033	6	7	
54	9.65 556	24	9.70 529	31	10.29 471	9.95 027	6	6	
55	9.65 580	25	9.70 560	32	10.29 440	9.95 020	7	5	
56	9.65 605	25	9.70 592	31	10.29 408	9.95 014	6	4	
57	9.65 630	25	9.70 623	31	10.29 377	9.95 007	7	3	
58	9.65 655	25	9.70 654	31	10.29 346	9.95 001	6	2	
59	9.65 680	25	9.70 685	32	10.29 315	9.94 995	6	1	
60	9.65 705		9.70 717		10.29 283	9.94 988	7	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	32	31
1	3.2	3.1
2	6.4	6.2
3	9.6	9.3
4	12.8	12.4
5	16.0	15.5
6	19.2	18.6
7	22.4	21.7
8	25.6	24.8
9	28.8	27.9

	26	25	24
1	2.6	2.5	2.4
2	5.2	5.0	4.8
3	7.8	7.5	7.2
4	10.4	10.0	9.6
5	13.0	12.5	12.0
6	15.6	15.0	14.4
7	18.2	17.5	16.8
8	20.8	20.0	19.2
9	23.4	22.5	21.6

	7	6
1	0.7	0.6
2	1.4	1.2
3	2.1	1.8
4	2.8	2.4
5	3.5	3.0
6	4.2	3.6
7	4.9	4.2
8	5.6	4.8
9	6.3	5.4

63°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.65 705		9.70 717		10.29 283	9.94 988		**60**	
1	9.65 729	24	9.70 748	31	10.29 252	9.94 982	6	59	
2	9.65 754	25	9.70 779	31	10.29 221	9.94 975	7	58	
3	9.65 779	25	9.70 810	31	10.29 190	9.94 969	6	57	
4	9.65 804	25	9.70 841	32	10.29 159	9.94 962	7	56	
5	9.65 828	24	9.70 873	31	10.29 127	9.94 956	6	55	
6	9.65 853	25	9.70 904	31	10.29 096	9.94 949	7	54	
7	9.65 878	25	9.70 935	31	10.29 065	9.94 943	6	53	
8	9.65 902	24	9.70 966	31	10.29 034	9.94 936	7	52	
9	9.65 927	25	9.70 997	31	10.29 003	9.94 930	6	51	
10	9.65 952	25	9.71 028	31	10.28 972	9.94 923	7	**50**	
11	9.65 976	24	9.71 059	31	10.28 941	9.94 917	6	49	
12	9.66 001	25	9.71 090	31	10.28 910	9.94 911	6	48	
13	9.66 025	24	9.71 121	32	10.28 879	9.94 904	7	47	
14	9.66 050	25	9.71 153	31	10.28 847	9.94 898	6	46	
15	9.66 075	25	9.71 184	31	10.28 816	9.94 891	7	45	
16	9.66 099	24	9.71 215	31	10.28 785	9.94 885	6	44	
17	9.66 124	25	9.71 246	31	10.28 754	9.94 878	7	43	
18	9.66 148	24	9.71 277	31	10.28 723	9.94 871	7	42	
19	9.66 173	25	9.71 308	31	10.28 692	9.94 865	6	41	
20	9.66 197	24	9.71 339	31	10.28 661	9.94 858	7	**40**	
21	9.66 221	24	9.71 370	31	10.28 630	9.94 852	6	39	
22	9.66 246	25	9.71 401	30	10.28 599	9.94 845	7	38	
23	9.66 270	24	9.71 431	31	10.28 569	9.94 839	6	37	
24	9.66 295	25	9.71 462	31	10.28 538	9.94 832	7	36	
25	9.66 319	24	9.71 493	31	10.28 507	9.94 826	6	35	
26	9.66 343	24	9.71 524	31	10.28 476	9.94 819	7	34	
27	9.66 368	25	9.71 555	31	10.28 445	9.94 813	6	33	
28	9.66 392	24	9.71 586	31	10.28 414	9.94 806	7	32	
29	9.66 416	24	9.71 617	31	10.28 383	9.94 799	7	31	
30	9.66 441	25	9.71 648	31	10.28 352	9.94 793	6	**30**	
31	9.66 465	24	9.71 679	30	10.28 321	9.94 786	7	29	
32	9.66 489	24	9.71 709	31	10.28 291	9.94 780	6	28	
33	9.66 513	24	9.71 740	31	10.28 260	9.94 773	7	27	
34	9.66 537	25	9.71 771	31	10.28 229	9.94 767	6	26	
35	9.66 562	24	9.71 802	31	10.28 198	9.94 760	7	25	
36	9.66 586	24	9.71 833	30	10.28 167	9.94 753	7	24	
37	9.66 610	24	9.71 863	31	10.28 137	9.94 747	6	23	
38	9.66 634	24	9.71 894	31	10.28 106	9.94 740	7	22	
39	9.66 658	24	9.71 925	30	10.28 075	9.94 734	6	21	
40	9.66 682	24	9.71 955	31	10.28 045	9.94 727	7	**20**	
41	9.66 706	25	9.71 986	31	10.28 014	9.94 720	7	19	
42	9.66 731	24	9.72 017	31	10.27 983	9.94 714	6	18	
43	9.66 755	24	9.72 048	30	10.27 952	9.94 707	7	17	
44	9.66 779	24	9.72 078	31	10.27 922	9.94 700	7	16	
45	9.66 803	24	9.72 109	31	10.27 891	9.94 694	6	15	
46	9.66 827	24	9.72 140	30	10.27 860	9.94 687	7	14	
47	9.66 851	24	9.72 170	31	10.27 830	9.94 680	7	13	
48	9.66 875	24	9.72 201	30	10.27 799	9.94 674	6	12	
49	9.66 899	23	9.72 231	31	10.27 769	9.94 667	7	11	
50	9.66 922	24	9.72 262	31	10.27 738	9.94 660	7	**10**	
51	9.66 946	24	9.72 293	30	10.27 707	9.94 654	6	9	
52	9.66 970	24	9.72 323	31	10.27 677	9.94 647	7	8	
53	9.66 994	24	9.72 354	30	10.27 646	9.94 640	7	7	
54	9.67 018	24	9.72 384	31	10.27 616	9.94 634	6	6	
55	9.67 042	24	9.72 415	30	10.27 585	9.94 627	7	5	
56	9.67 066	24	9.72 445	31	10.27 555	9.94 620	7	4	
57	9.67 090	23	9.72 476	30	10.27 524	9.94 614	6	3	
58	9.67 113	24	9.72 506	31	10.27 494	9.94 607	7	2	
59	9.67 137	24	9.72 537	30	10.27 463	9.94 600	7	1	
60	9.67 161		9.72 567		10.27 433	9.94 593		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	32	31	30
1	3.2	3.1	3.0
2	6.4	6.2	6.0
3	9.6	9.3	9.0
4	12.8	12.4	12.0
5	16.0	15.5	15.0
6	19.2	18.6	18.0
7	22.4	21.7	21.0
8	25.6	24.8	24.0
9	28.8	27.9	27.0

	25	24	23
1	2.5	2.4	2.3
2	5.0	4.8	4.6
3	7.5	7.2	6.9
4	10.0	9.6	9.2
5	12.5	12.0	11.5
6	15.0	14.4	13.8
7	17.5	16.8	16.1
8	20.0	19.2	18.4
9	22.5	21.6	20.7

	7	6
1	0.7	0.6
2	1.4	1.2
3	2.1	1.8
4	2.8	2.4
5	3.5	3.0
6	4.2	3.6
7	4.9	4.2
8	5.6	4.8
9	6.3	5.4

TABLE II

28°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.67 161		9.72 567		10.27 433	9.94 593		**60**	
1	9.67 185	24	9.72 598	31	10.27 402	9.94 587	6	59	
2	9.67 208	23	9.72 628	30	10.27 372	9.94 580	7	58	
3	9.67 232	24	9.72 659	31	10.27 341	9.94 573	7	57	
4	9.67 256	24	9.72 689	30	10.27 311	9.94 567	6	56	
5	9.67 280	23	9.72 720	31	10.27 280	9.94 560	7	55	
6	9.67 303	24	9.72 750	30	10.27 250	9.94 553	7	54	
7	9.67 327	23	9.72 780	30	10.27 220	9.94 546	7	53	
8	9.67 350	24	9.72 811	31	10.27 189	9.94 540	6	52	
9	9.67 374	24	9.72 841	30	10.27 159	9.94 533	7	51	
10	9.67 398	23	9.72 872	31	10.27 128	9.94 526	7	**50**	
11	9.67 421	24	9.72 902	30	10.27 098	9.94 519	7	49	
12	9.67 445	23	9.72 932	30	10.27 068	9.94 513	6	48	
13	9.67 468	24	9.72 963	31	10.27 037	9.94 506	7	47	
14	9.67 492	23	9.72 993	30	10.27 007	9.94 499	7	46	
15	9.67 515	24	9.73 023	30	10.26 977	9.94 492	7	45	
16	9.67 539	23	9.73 054	31	10.26 946	9.94 485	7	44	
17	9.67 562	24	9.73 084	30	10.26 916	9.94 479	6	43	
18	9.67 586	23	9.73 114	30	10.26 886	9.94 472	7	42	
19	9.67 609	24	9.73 144	30	10.26 856	9.94 465	7	41	
20	9.67 633	23	9.73 175	31	10.26 825	9.94 458	7	**40**	
21	9.67 656	24	9.73 205	30	10.26 795	9.94 451	7	39	
22	9.67 680	23	9.73 235	30	10.26 765	9.94 445	6	38	
23	9.67 703	23	9.73 265	30	10.26 735	9.94 438	7	37	
24	9.67 726	24	9.73 295	30	10.26 705	9.94 431	7	36	
25	9.67 750	23	9.73 326	31	10.26 674	9.94 424	7	35	
26	9.67 773	23	9.73 356	30	10.26 644	9.94 417	7	34	
27	9.67 796	24	9.73 386	30	10.26 614	9.94 410	7	33	
28	9.67 820	23	9.73 416	30	10.26 584	9.94 404	6	32	
29	9.67 843	23	9.73 446	30	10.26 554	9.94 397	7	31	
30	9.67 866	24	9.73 476	31	10.26 524	9.94 390	7	**30**	
31	9.67 890	23	9.73 507	30	10.26 493	9.94 383	7	29	
32	9.67 913	23	9.73 537	30	10.26 463	9.94 376	7	28	
33	9.67 936	23	9.73 567	30	10.26 433	9.94 369	7	27	
34	9.67 959	23	9.73 597	30	10.26 403	9.94 362	7	26	
35	9.67 982	24	9.73 627	30	10.26 373	9.94 355	6	25	
36	9.68 006	23	9.73 657	30	10.26 343	9.94 349	7	24	
37	9.68 029	23	9.73 687	30	10.26 313	9.94 342	7	23	
38	9.68 052	23	9.73 717	30	10.26 283	9.94 335	7	22	
39	9.68 075	23	9.73 747	30	10.26 253	9.94 328	7	21	
40	9.68 098	23	9.73 777	30	10.26 223	9.94 321	7	**20**	
41	9.68 121	23	9.73 807	30	10.26 193	9.94 314	7	19	
42	9.68 144	23	9.73 837	30	10.26 163	9.94 307	7	18	
43	9.68 167	23	9.73 867	30	10.26 133	9.94 300	7	17	
44	9.68 190	23	9.73 897	30	10.26 103	9.94 293	7	16	
45	9.68 213	24	9.73 927	30	10.26 073	9.94 286	7	15	
46	9.68 237	23	9.73 957	30	10.26 043	9.94 279	7	14	
47	9.68 260	23	9.73 987	30	10.26 013	9.94 273	6	13	
48	9.68 283	22	9.74 017	30	10.25 983	9.94 266	7	12	
49	9.68 305	23	9.74 047	30	10.25 953	9.94 259	7	11	
50	9.68 328	23	9.74 077	30	10.25 923	9.94 252	7	**10**	
51	9.68 351	23	9.74 107	30	10.25 893	9.94 245	7	9	
52	9.68 374	23	9.74 137	29	10.25 863	9.94 238	7	8	
53	9.68 397	23	9.74 166	30	10.25 834	9.94 231	7	7	
54	9.68 420	23	9.74 196	30	10.25 804	9.94 224	7	6	
55	9.68 443	23	9.74 226	30	10.25 774	9.94 217	7	5	
56	9.68 466	23	9.74 256	30	10.25 744	9.94 210	7	4	
57	9.68 489	23	9.74 286	30	10.25 714	9.94 203	7	3	
58	9.68 512	22	9.74 316	29	10.25 684	9.94 196	7	2	
59	9.68 534	23	9.74 345	30	10.25 655	9.94 189	7	1	
60	9.68 557		9.74 375		10.25 625	9.94 182		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	31	30	29
1	3.1	3.0	2.9
2	6.2	6.0	5.8
3	9.3	9.0	8.7
4	12.4	12.0	11.6
5	15.5	15.0	14.5
6	18.6	18.0	17.4
7	21.7	21.0	20.3
8	24.8	24.0	23.2
9	27.9	27.0	26.1

	24	23	22
1	2.4	2.3	2.2
2	4.8	4.6	4.4
3	7.2	6.9	6.6
4	9.6	9.2	8.8
5	12.0	11.5	11.0
6	14.4	13.8	13.2
7	16.8	16.1	15.4
8	19.2	18.4	17.6
9	21.6	20.7	19.8

	7	6
1	0.7	0.6
2	1.4	1.2
3	2.1	1.8
4	2.8	2.4
5	3.5	3.0
6	4.2	3.6
7	4.9	4.2
8	5.6	4.8
9	6.3	5.4

61°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.68 557		9.74 375		10.25 625	9.94 182		**60**	
1	9.68 580	23	9.74 405	30	10.25 595	9.94 175	7	59	
2	9.68 603	23	9.74 435	30	10.25 565	9.94 168	7	58	
3	9.68 625	22	9.74 465	30	10.25 535	9.94 161	7	57	
4	9.68 648	23	9.74 494	29	10.25 506	9.94 154	7	56	
5	9.68 671	23	9.74 524	30	10.25 476	9.94 147	7	55	
6	9.68 694	23	9.74 554	30	10.25 446	9.94 140	7	54	
7	9.68 716	22	9.74 583	29	10.25 417	9.94 133	7	53	
8	9.68 739	23	9.74 613	30	10.25 387	9.94 126	7	52	
9	9.68 762	23	9.74 643	30	10.25 357	9.94 119	7	51	
10	9.68 784	22	9.74 673	30	10.25 327	9.94 112	7	**50**	
11	9.68 807	23	9.74 702	29	10.25 298	9.94 105	7	49	
12	9.68 829	22	9.74 732	30	10.25 268	9.94 098	7	48	
13	9.68 852	23	9.74 762	30	10.25 238	9.94 090	8	47	
14	9.68 875	22	9.74 791	29	10.25 209	9.94 083	7	46	
15	9.68 897	23	9.74 821	30	10.25 179	9.94 076	7	45	
16	9.68 920	22	9.74 851	30	10.25 149	9.94 069	7	44	
17	9.68 942	23	9.74 880	29	10.25 120	9.94 062	7	43	
18	9.68 965	22	9.74 910	30	10.25 090	9.94 055	7	42	
19	9.68 987	23	9.74 939	29	10.25 061	9.94 048	7	41	
20	9.69 010	22	9.74 969	30	10.25 031	9.94 041	7	**40**	
21	9.69 032	23	9.74 998	29	10.25 002	9.94 034	7	39	
22	9.69 055	22	9.75 028	30	10.24 972	9.94 027	7	38	
23	9.69 077	23	9.75 058	30	10.24 942	9.94 020	7	37	
24	9.69 100	22	9.75 087	29	10.24 913	9.94 012	8	36	
25	9.69 122	22	9.75 117	30	10.24 883	9.94 005	7	35	
26	9.69 144	23	9.75 146	29	10.24 854	9.93 998	7	34	
27	9.69 167	22	9.75 176	30	10.24 824	9.93 991	7	33	
28	9.69 189	23	9.75 205	29	10.24 795	9.93 984	7	32	
29	9.69 212	22	9.75 235	30	10.24 765	9.93 977	7	31	
30	9.69 234	22	9.75 264	29	10.24 736	9.93 970	7	**30**	
31	9.69 256	23	9.75 294	30	10.24 706	9.93 963	8	29	
32	9.69 279	22	9.75 323	29	10.24 677	9.93 955	7	28	
33	9.69 301	22	9.75 353	30	10.24 647	9.93 948	7	27	
34	9.69 323	22	9.75 382	29	10.24 618	9.93 941	7	26	
35	9.69 345	23	9.75 411	29	10.24 589	9.93 934	7	25	
36	9.69 368	22	9.75 441	30	10.24 559	9.93 927	7	24	
37	9.69 390	22	9.75 470	29	10.24 530	9.93 920	8	23	
38	9.69 412	22	9.75 500	30	10.24 500	9.93 912	7	22	
39	9.69 434	22	9.75 529	29	10.24 471	9.93 905	7	21	
40	9.69 456	23	9.75 558	29	10.24 442	9.93 898	7	**20**	
41	9.69 479	22	9.75 588	30	10.24 412	9.93 891	7	19	
42	9.69 501	22	9.75 617	29	10.24 383	9.93 884	8	18	
43	9.69 523	22	9.75 647	30	10.24 353	9.93 876	7	17	
44	9.69 545	22	9.75 676	29	10.24 324	9.93 869	7	16	
45	9.69 567	22	9.75 705	29	10.24 295	9.93 862	7	15	
46	9.69 589	22	9.75 735	30	10.24 265	9.93 855	7	14	
47	9.69 611	22	9.75 764	29	10.24 236	9.93 847	8	13	
48	9.69 633	22	9.75 793	29	10.24 207	9.93 840	7	12	
49	9.69 655	22	9.75 822	29	10.24 178	9.93 833	7	11	
50	9.69 677	22	9.75 852	30	10.24 148	9.93 826	7	**10**	
51	9.69 699	22	9.75 881	29	10.24 119	9.93 819	7	9	
52	9.69 721	22	9.75 910	29	10.24 090	9.93 811	8	8	
53	9.69 743	22	9.75 939	29	10.24 061	9.93 804	7	7	
54	9.69 765	22	9.75 969	30	10.24 031	9.93 797	7	6	
55	9.69 787	22	9.75 998	29	10.24 002	9.93 789	8	5	
56	9.69 809	22	9.76 027	29	10.23 973	9.93 782	7	4	
57	9.69 831	22	9.76 056	29	10.23 944	9.93 775	7	3	
58	9.69 853	22	9.76 086	30	10.23 914	9.93 768	7	2	
59	9.69 875	22	9.76 115	29	10.23 885	9.93 760	8	1	
60	9.69 897		9.76 144	29	10.23 856	9.93 753	7	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	30	29
1	3.0	2.9
2	6.0	5.8
3	9.0	8.7
4	12.0	11.6
5	15.0	14.5
6	18.0	17.4
7	21.0	20.3
8	24.0	23.2
9	27.0	26.1

	23	22
1	2.3	2.2
2	4.6	4.4
3	6.9	6.6
4	9.2	8.8
5	11.5	11.0
6	13.8	13.2
7	16.1	15.4
8	18.4	17.6
9	20.7	19.8

	8	7
1	0.8	0.7
2	1.6	1.4
3	2.4	2.1
4	3.2	2.8
5	4.0	3.5
6	4.8	4.2
7	5.6	4.9
8	6.4	5.6
9	7.2	6.3

TABLE II

30°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.69 897		9.76 144		10.23 856	9.93 753		**60**	
1	9.69 919	22	9.76 173	29	10.23 827	9.93 746	7	59	
2	9.69 941	22	9.76 202	29	10.23 798	9.93 738	8	58	
3	9.69 963	22	9.76 231	29	10.23 769	9.93 731	7	57	
4	9.69 984	21	9.76 261	30	10.23 739	9.93 724	7	56	
5	9.70 006	22	9.76 290	29	10.23 710	9.93 717	7	55	
6	9.70 028	22	9.76 319	29	10.23 681	9.93 709	8	54	
7	9.70 050	22	9.76 348	29	10.23 652	9.93 702	7	53	
8	9.70 072	22	9.76 377	29	10.23 623	9.93 695	7	52	
9	9.70 093	21	9.76 406	29	10.23 594	9.93 687	8	51	
10	9.70 115	22	9.76 435	29	10.23 565	9.93 680	7	**50**	
11	9.70 137	22	9.76 464	29	10.23 536	9.93 673	7	49	
12	9.70 159	22	9.76 493	29	10.23 507	9.93 665	8	48	
13	9.70 180	21	9.76 522	29	10.23 478	9.93 658	7	47	
14	9.70 202	22	9.76 551	29	10.23 449	9.93 650	8	46	
15	9.70 224	22	9.76 580	29	10.23 420	9.93 643	7	45	
16	9.70 245	21	9.76 609	29	10.23 391	9.93 636	7	44	
17	9.70 267	22	9.76 639	30	10.23 361	9.93 628	8	43	
18	9.70 288	21	9.76 668	29	10.23 332	9.93 621	7	42	
19	9.70 310	22	9.76 697	29	10.23 303	9.93 614	7	41	
20	9.70 332	22	9.76 725	28	10.23 275	9.93 606	8	**40**	
21	9.70 353	21	9.76 754	29	10.23 246	9.93 599	7	39	
22	9.70 375	22	9.76 783	29	10.23 217	9.93 591	8	38	
23	9.70 396	21	9.76 812	29	10.23 188	9.93 584	7	37	
24	9.70 418	22	9.76 841	29	10.23 159	9.93 577	7	36	
25	9.70 439	21	9.76 870	29	10.23 130	9.93 569	8	35	
26	9.70 461	22	9.76 899	29	10.23 101	9.93 562	7	34	
27	9.70 482	21	9.76 928	29	10.23 072	9.93 554	8	33	
28	9.70 504	22	9.76 957	29	10.23 043	9.93 547	7	32	
29	9.70 525	21	9.76 986	29	10.23 014	9.93 539	8	31	
30	9.70 547	22	9.77 015	29	10.22 985	9.93 532	7	**30**	
31	9.70 568	21	9.77 044	29	10.22 956	9.93 525	7	29	
32	9.70 590	22	9.77 073	28	10.22 927	9.93 517	8	28	
33	9.70 611	21	9.77 101	29	10.22 899	9.93 510	7	27	
34	9.70 633	22	9.77 130	29	10.22 870	9.93 502	8	26	
35	9.70 654	21	9.77 159	29	10.22 841	9.93 495	7	25	
36	9.70 675	21	9.77 188	29	10.22 812	9.93 487	8	24	
37	9.70 796	22	9.77 217	29	10.22 783	9.93 480	7	23	
38	9.70 718	21	9.77 246	28	10.22 754	9.93 472	8	22	
39	9.70 739	21	9.77 274	29	10.22 726	9.93 465	7	21	
40	9.70 761	22	9.77 303	29	10.22 697	9.93 457	8	**20**	
41	9.70 782	21	9.77 332	29	10.22 668	9.93 450	7	19	
42	9.70 803	21	9.77 361	29	10.22 639	9.93 442	8	18	
43	9.70 824	21	9.77 390	29	10.22 610	9.93 435	7	17	
44	9.70 846	22	9.77 418	28	10.22 582	9.93 427	8	16	
45	9.70 867	21	9.77 447	29	10.22 553	9.93 420	7	15	
46	9.70 888	21	9.77 476	29	10.22 524	9.93 412	8	14	
47	9.70 909	21	9.77 505	29	10.22 495	9.93 405	7	13	
48	9.70 931	22	9.77 533	28	10.22 467	9.93 397	8	12	
49	9.70 952	21	9.77 562	29	10.22 438	9.93 390	7	11	
50	9.70 973	21	9.77 591	29	10.22 409	9.93 382	8	**10**	
51	9.70 994	21	9.77 619	28	10.22 381	9.93 375	7	9	
52	9.71 015	21	9.77 648	29	10.22 352	9.93 367	8	8	
53	9.71 036	22	9.77 677	29	10.22 323	9.93 360	7	7	
54	9.71 058	21	9.77 706	28	10.22 294	9.93 352	8	6	
55	9.71 079	21	9.77 734	29	10.22 266	9.93 344	8	5	
56	9.71 100	21	9.77 763	29	10.22 237	9.93 337	7	4	
57	9.71 121	21	9.77 791	28	10.22 209	9.93 329	8	3	
58	9.71 142	21	9.77 820	29	10.22 180	9.93 322	7	2	
59	9.71 163	21	9.77 849	29	10.22 151	9.93 314	8	1	
60	9.71 184		9.77 877	28	10.22 123	9.93 307	7	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	30	29	28
1	3.0	2.9	2.8
2	6.0	5.8	5.6
3	9.0	8.7	8.4
4	12.0	11.6	11.2
5	15.0	14.5	14.0
6	18.0	17.4	16.8
7	21.0	20.3	19.6
8	24.0	23.2	22.4
9	27.0	26.1	25.2

	22	21
1	2.2	2.1
2	4.4	4.2
3	6.6	6.3
4	8.8	8.4
5	11.0	10.5
6	13.2	12.6
7	15.4	14.7
8	17.6	16.8
9	19.8	18.9

	8	7
1	0.8	0.7
2	1.6	1.4
3	2.4	2.1
4	3.2	2.8
5	4.0	3.5
6	4.8	4.2
7	5.6	4.9
8	6.4	5.6
9	7.2	6.3

59°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.71 184		9.77 877		10.22 123	9.93 307		60	
1	9.71 205	21	9.77 906	29	10.22 094	9.93 299	8	59	
2	9.71 226	21	9.77 935	29	10.22 065	9.93 291	8	58	
3	9.71 247	21	9.77 963	28	10.22 037	9.93 284	7	57	
4	9.71 268	21	9.77 992	29	10.22 008	9.93 276	8	56	
5	9.71 289	21	9.78 020	28	10.21 980	9.93 269	7	55	
6	9.71 310	21	9.78 049	29	10.21 951	9.93 261	8	54	
7	9.71 331	21	9.78 077	28	10.21 923	9.93 253	8	53	
8	9.71 352	21	9.78 106	29	10.21 894	9.93 246	7	52	
9	9.71 373	20	9.78 135	29	10.21 865	9.93 238	8	51	
10	9.71 393	21	9.78 163	28	10.21 837	9.93 230	8	50	
11	9.71 414	21	9.78 192	29	10.21 808	9.93 223	7	49	
12	9.71 435	21	9.78 220	28	10.21 780	9.93 215	8	48	
13	9.71 456	21	9.78 249	29	10.21 751	9.93 207	8	47	
14	9.71 477	21	9.78 277	28	10.21 723	9.93 200	7	46	
15	9.71 498	21	9.78 306	29	10.21 694	9.93 192	8	45	
16	9.71 519	20	9.78 334	28	10.21 666	9.93 184	8	44	
17	9.71 539	21	9.78 363	29	10.21 637	9.93 177	7	43	
18	9.71 560	21	9.78 391	28	10.21 609	9.93 169	8	42	
19	9.71 581	21	9.78 419	28	10.21 581	9.93 161	8	41	
20	9.71 602	20	9.78 448	29	10.21 552	9.93 154	7	40	
21	9.71 622	21	9.78 476	28	10.21 524	9.93 146	8	39	
22	9.71 643	21	9.78 505	29	10.21 495	9.93 138	8	38	
23	9.71 664	21	9.78 533	28	10.21 467	9.93 131	7	37	
24	9.71 685	20	9.78 562	29	10.21 438	9.93 123	8	36	
25	9.71 705	21	9.78 590	28	10.21 410	9.93 115	8	35	
26	9.71 726	21	9.78 618	28	10.21 382	9.93 108	7	34	
27	9.71 747	20	9.78 647	29	10.21 353	9.93 100	8	33	
28	9.71 767	21	9.78 675	28	10.21 325	9.93 092	8	32	
29	9.71 788	21	9.78 704	29	10.21 296	9.93 084	8	31	
30	9.71 809	20	9.78 732	28	10.21 268	9.93 077	7	30	
31	9.71 829	21	9.78 760	28	10.21 240	9.93 069	8	29	
32	9.71 850	20	9.78 789	29	10.21 211	9.93 061	8	28	
33	9.71 870	21	9.78 817	28	10.21 183	9.93 053	8	27	
34	9.71 891	20	9.78 845	28	10.21 155	9.93 046	7	26	
35	9.71 911	21	9.78 874	29	10.21 126	9.93 038	8	25	
36	9.71 932	20	9.78 902	28	10.21 098	9.93 030	8	24	
37	9.71 952	21	9.78 930	28	10.21 070	9.93 022	8	23	
38	9.71 973	21	9.78 959	29	10.21 041	9.93 014	8	22	
39	9.71 994	20	9.78 987	28	10.21 013	9.93 007	7	21	
40	9.72 014	20	9.79 015	28	10.20 985	9.92 999	8	20	
41	9.72 034	21	9.79 043	28	10.20 957	9.92 991	8	19	
42	9.72 055	20	9.79 072	29	10.20 928	9.92 983	8	18	
43	9.72 075	21	9.79 100	28	10.20 900	9.92 976	7	17	
44	9.72 096	20	9.79 128	28	10.20 872	9.92 968	8	16	
45	9.72 116	20	9.79 156	28	10.20 844	9.92 960	8	15	
46	9.72 137	21	9.79 185	29	10.20 815	9.92 952	8	14	
47	9.72 157	20	9.79 213	28	10.20 787	9.92 944	8	13	
48	9.72 177	20	9.79 241	28	10.20 759	9.92 936	8	12	
49	9.72 198	21	9.79 269	28	10.20 731	9.92 929	7	11	
50	9.72 218	20	9.79 297	28	10.20 703	9.92 921	8	10	
51	9.72 238	20	9.79 326	29	10.20 674	9.92 913	8	9	
52	9.72 259	21	9.79 354	28	10.20 646	9.92 905	8	8	
53	9.72 279	20	9.79 382	28	10.20 618	9.92 897	8	7	
54	9.72 299	20	9.79 410	28	10.20 590	9.92 889	8	6	
55	9.72 320	21	9.79 438	28	10.20 562	9.92 881	7	5	
56	9.72 340	20	9.79 466	28	10.20 534	9.92 874	8	4	
57	9.72 360	20	9.79 495	29	10.20 505	9.92 866	8	3	
58	9.72 381	21	9.79 523	28	10.20 477	9.92 858	8	2	
59	9.72 401	20	9.79 551	28	10.20 449	9.92 850	8	1	
60	9.72 421		9 79 579		10.20 421	9.92 842		0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop Pts.

	29	28
1	2.9	2.8
2	5.8	5.6
3	8.7	8.4
4	11.6	11.2
5	14.5	14.0
6	17.4	16.8
7	20.3	19.6
8	23.2	22.4
9	26.1	25.2

	21	20
1	2.1	2.0
2	4.2	4.0
3	6.3	6.0
4	8.4	8.0
5	10.5	10.0
6	12.6	12.0
7	14.7	14.0
8	16.8	16.0
9	18.9	18.0

	8	7
1	0.8	0.7
2	1.6	1.4
3	2.4	2.1
4	3.2	2.8
5	4.0	3.5
6	4.8	4.2
7	5.6	4.9
8	6.4	5.6
9	7.2	6.3

TABLE II

32°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.72 421		9.79 579		10.20 421	9.92 842		**60**	
		20		28			8		
1	9.72 441	20	9.79 607	28	10.20 393	9.92 834	8	59	
2	9.72 461	21	9.79 635	28	10.20 365	9.92 826	8	58	
3	9.72 482		9.79 663		10.20 337	9.92 818	8	57	
		20		28			8		
4	9.72 502	20	9.79 691	28	10.20 309	9.92 810	7	56	
5	9.72 522	20	9.79 719	28	10.20 281	9.92 803	8	55	
6	9.72 542		9.79 747		10.20 253	9.92 795		54	
		20		29			8		
7	9.72 562	20	9.79 776	28	10.20 224	9.92 787	8	53	
8	9.72 582	20	9.79 804	28	10.20 196	9.92 779	8	52	
9	9.72 602		9.79 832		10.20 168	9.92 771		51	
		20		28			8		
10	9.72 622		9.79 860		10.20 140	9.92 763		**50**	
		21		28			8		
11	9.72 643	20	9.79 888	28	10.20 112	9.92 755	8	49	
12	9.72 663	20	9.79 916	28	10.20 084	9.92 747	8	48	
13	9.72 683		9.79 944		10.20 056	9.92 739	8	47	
		20		28			8		
14	9.72 703	20	9.79 972	28	10.20 028	9.92 731	8	46	
15	9.72 723	20	9.80 000	28	10.20 000	9.92 723	8	45	
16	9.72 743		9.80 028		10.19 972	9.92 715		44	
		20		28			8		
17	9.72 763	20	9.80 056	28	10.19 944	9.92 707	8	43	
18	9.72 783	20	9.80 084	28	10.19 916	9.92 699	8	42	
19	9.72 803		9.80 112		10.19 888	9.92 691		41	
		20		28			8		
20	9.72 823		9.80 140		10.19 860	9.92 683		**40**	
		20		28			8		
21	9.72 843	20	9.80 168	27	10.19 832	9.92 675	8	39	
22	9.72 863	20	9.80 195	28	10.19 805	9.92 667	8	38	
23	9.72 883		9.80 223		10.19 777	9.92 659	8	37	
		19		28			8		
24	9.72 902	20	9.80 251	28	10.19 749	9.92 651	8	36	
25	9.72 922	20	9.80 279	28	10.19 721	9.92 643	8	35	
26	9.72 942		9.80 307		10.19 693	9.92 635	8	34	
		20		28			8		
27	9.72 962	20	9.80 335	28	10.19 665	9.92 627	8	33	
28	9.72 982	20	9.80 363	28	10.19 637	9.92 619	8	32	
29	9.73 002		9.80 391		10.19 609	9.92 611	8	31	
		20		28			8		
30	9.73 022		9.80 419		10.19 581	9.92 603		**30**	
		19		28			8		
31	9.73 041	20	9.80 447	27	10.19 553	9.92 595	8	29	
32	9.73 061	20	9.80 474	28	10.19 526	9.92 587	8	28	
33	9.73 081		9.80 502		10.19 498	9.92 579	8	27	
		20		28			8		
34	9.73 101	20	9.80 530	28	10.19 470	9.92 571	8	26	
35	9.73 121	19	9.80 558	28	10.19 442	9.92 563	8	25	
36	9.73 140		9.80 586		10.19 414	9.92 555		24	
		20		28			9		
37	9.73 160	20	9.80 614	28	10.19 386	9.92 546	8	23	
38	9.73 180	20	9.80 642	27	10.19 358	9.92 538	8	22	
39	9.73 200		9.80 669		10.19 331	9.92 530		21	
		19		28			8		
40	9.73 219		9.80 697		10.19 303	9.92 522		**20**	
		20		28			8		
41	9.73 239	20	9.80 725	28	10.19 275	9.92 514	8	19	
42	9.73 259	19	9.80 753	28	10.19 247	9.92 506	8	18	
43	9.73 278		9.80 781		10.19 219	9.92 498	8	17	
		20		27			8		
44	9.73 298	20	9.80 808	28	10.19 192	9.92 490	8	16	
45	9.73 318	19	9.80 836	28	10.19 164	9.92 482	9	15	
46	9.73 337		9.80 864		10.19 136	9.92 473		14	
		20		28			8		
47	9.73 357	20	9.80 892	27	10.19 108	9.92 465	8	13	
48	9.73 377	19	9.80 919	28	10.19 081	9.92 457	8	12	
49	9.73 396		9.80 947		10.19 053	9.92 449	8	11	
		20		28					
50	9.73 416		9.80 975		10.19 025	9.92 441		**10**	
		19		28			8		
51	9.73 435	20	9.81 003	27	10.18 997	9.92 433	8	9	
52	9.73 455	19	9.81 030	28	10.18 970	9.92 425	9	8	
53	9.73 474		9.81 058		10.18 942	9.92 416	8	7	
		20		28			8		
54	9.73 494	19	9.81 086	27	10.18 914	9.92 408	8	6	
55	9.73 513	20	9.81 113	28	10.18 887	9.92 400	8	5	
56	9.73 533		9.81 141		10.18 859	9.92 392		4	
		19		28			8		
57	9.73 552	20	9.81 169	27	10.18 831	9.92 384	8	3	
58	9.73 572	19	9.81 196	28	10.18 804	9.92 376	9	2	
59	9.73 591		9.81 224		10.18 776	9.92 367	8	1	
		20		28					
60	9.73 611		9.81 252		10.18 748	9.92 359		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	29	28	27
1	2.9	2.8	2.7
2	5.8	5.6	5.4
3	8.7	8.4	8.1
4	11.6	11.2	10.8
5	14.5	14.0	13.5
6	17.4	16.8	16.2
7	20.3	19.6	18.9
8	23.2	22.4	21.6
9	26.1	25.2	24.3

	21	20	19
1	2.1	2.0	1.9
2	4.2	4.0	3.8
3	6.3	6.0	5.7
4	8.4	8.0	7.6
5	10.5	10.0	9.5
6	12.6	12.0	11.4
7	14.7	14.0	13.3
8	16.8	16.0	15.2
9	18.9	18.0	17.1

	9	8	7
1	0.9	0.8	0.7
2	1.8	1.6	1.4
3	2.7	2.4	2.1
4	3.6	3.2	2.8
5	4.5	4.0	3.5
6	5.4	4.8	4.2
7	6.3	5.6	4.9
8	7.2	6.4	5.6
9	8.1	7.2	6.3

57°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d	′
0	9.73 611		9.81 252		10.18 748	9.92 359		60
1	9.73 630	19	9.81 279	27	10.18 721	9.92 351	8	59
2	9.73 650	20	9.81 307	28	10.18 693	9.92 343	8	58
3	9.73 669	19	9.81 335	28	10.18 665	9.92 335	8	57
4	9.73 689	20	9.81 362	27	10.18 638	9.92 326	9	56
5	9.73 708	19	9.81 390	28	10.18 610	9.92 318	8	55
6	9.73 727	19	9.81 418	28	10.18 582	9.92 310	8	54
7	9.73 747	20	9.81 445	27	10.18 555	9.92 302	8	53
8	9.73 766	19	9.81 473	28	10.18 527	9.92 293	9	52
9	9.73 785	19	9.81 500	27	10.18 500	9.92 285	8	51
10	9.73 805	20	9.81 528	28	10.18 472	9.92 277	8	50
11	9.73 824	19	9.81 556	28	10.18 444	9.92 269	8	49
12	9.73 843	19	9.81 583	27	10.18 417	9.92 260	9	48
13	9.73 863	20	9.81 611	28	10.18 389	9.92 252	8	47
14	9.73 882	19	9.81 638	27	10.18 362	9.92 244	8	46
15	9.73 901	19	9.81 666	28	10.18 334	9.92 235	9	45
16	9.73 921	20	9.81 693	27	10.18 307	9.92 227	8	44
17	9.73 940	19	9.81 721	28	10.18 279	9.92 219	8	43
18	9.73 959	19	9.81 748	27	10.18 252	9.92 211	8	42
19	9.73 978	19	9.81 776	28	10.18 224	9.92 202	9	41
20	9.73 997	19	9.81 803	27	10.18 197	9.92 194	8	40
21	9.74 017	20	9.81 831	28	10.18 169	9.92 186	8	39
22	9.74 036	19	9.81 858	27	10.18 142	9.92 177	9	38
23	9.74 055	19	9.81 886	28	10.18 114	9.92 169	8	37
24	9.74 074	19	9.81 913	27	10.18 087	9.92 161	8	36
25	9.74 093	19	9.81 941	28	10.18 059	9.92 152	9	35
26	9.74 113	20	9.81 968	27	10.18 032	9.92 144	8	34
27	9.74 132	19	9.81 996	28	10.18 004	9.92 136	8	33
28	9.74 151	19	9.82 023	27	10.17 977	9.92 127	9	32
29	9.74 170	19	9.82 051	28	10.17 949	9.92 119	8	31
30	9.74 189	19	9.82 078	27	10.17 922	9.92 111	8	30
31	9.74 208	19	9.82 106	28	10.17 894	9.92 102	9	29
32	9.74 227	19	9.82 133	27	10.17 867	9.92 094	8	28
33	9.74 246	19	9.82 161	28	10.17 839	9.92 086	8	27
34	9.74 265	19	9.82 188	27	10.17 812	9.92 077	9	26
35	9.74 284	19	9.82 215	27	10.17 785	9.92 069	8	25
36	9.74 303	19	9.82 243	28	10.17 757	9.92 060	9	24
37	9.74 322	19	9.82 270	27	10.17 730	9.92 052	8	23
38	9.74 341	19	9.82 298	28	10.17 702	9.92 044	8	22
39	9.74 360	19	9.82 325	27	10.17 675	9.92 035	9	21
40	9.74 379	19	9.82 352	27	10.17 648	9.92 027	8	20
41	9.74 398	19	9.82 380	28	10.17 620	9.92 018	9	19
42	9.74 417	19	9.82 407	27	10.17 593	9.92 010	8	18
43	9.74 436	19	9.82 435	28	10.17 565	9.92 002	8	17
44	9.74 455	19	9.82 462	27	10.17 538	9.91 993	9	16
45	9.74 474	19	9.82 489	27	10.17 511	9.91 985	8	15
46	9.74 493	19	9.82 517	28	10.17 483	9.91 976	9	14
47	9.74 512	19	9.82 544	27	10.17 456	9.91 968	8	13
48	9.74 531	18	9.82 571	27	10.17 429	9.91 959	9	12
49	9.74 549	19	9.82 599	28	10.17 401	9.91 951	8	11
50	9.74 568	19	9.82 626	27	10.17 374	9.91 942	9	10
51	9.74 587	19	9.82 653	27	10.17 347	9.91 934	8	9
52	9.74 606	19	9.82 681	28	10.17 319	9.91 925	9	8
53	9.74 625	19	9.82 708	27	10.17 292	9.91 917	8	7
54	9.74 644	18	9.82 735	27	10.17 265	9.91 908	9	6
55	9.74 662	19	9.82 762	27	10.17 238	9.91 900	8	5
56	9.74 681	19	9.82 790	28	10.17 210	9.91 891	9	4
57	9.74 700	19	9.82 817	27	10.17 183	9.91 883	8	3
58	9.74 719	18	9.82 844	27	10.17 156	9.91 874	9	2
59	9.74 737	19	9.82 871	28	10.17 129	9.91 866	8	1
60	9.74 756		9.82 899		10.17 101	9.91 857	9	0
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′

Prop. Pts.

	28	27
1	2.8	2.7
2	5.6	5.4
3	8.4	8.1
4	11.2	10.8
5	14.0	13.5
6	16.8	16.2
7	19.6	18.9
8	22.4	21.6
9	25.2	24.3

	20	19	18
1	2.0	1.9	1.8
2	4.0	3.8	3.6
3	6.0	5.7	5.4
4	8.0	7.6	7.2
5	10.0	9.5	9.0
6	12.0	11.4	10.8
7	14.0	13.3	12.6
8	16.0	15.2	14.4
9	18.0	17.1	16.2

	9	8
1	0.9	0.8
2	1.8	1.6
3	2.7	2.4
4	3.6	3.2
5	4.5	4.0
6	5.4	4.8
7	6.3	5.6
8	7.2	6.4
9	8.1	7.2

TABLE II

34°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.74 756		9.82 899		10.17 101	9.91 857		**60**	
1	9.74 775	19	9.82 926	27	10.17 074	9.91 849	8	59	
2	9.74 794	19	9.82 953	27	10.17 047	9.91 840	9	58	
3	9.74 812	18	9.82 980	27	10.17 020	9.91 832	8	57	
4	9.74 831	19	9.83 008	28	10.16 992	9.91 823	9	56	
5	9.74 850	19	9.83 035	27	10.16 965	9.91 815	8	55	
6	9.74 868	18	9.83 062	27	10.16 938	9.91 806	9	54	
7	9.74 887	19	9.83 089	27	10.16 911	9.91 798	8	53	
8	9.74 906	19	9.83 117	28	10.16 883	9.91 789	9	52	
9	9.74 924	18	9.83 144	27	10.16 856	9.91 781	8	51	
10	9.74 943	19	9.83 171	27	10.16 829	9.91 772	9	**50**	
11	9.74 961	18	9.83 198	27	10.16 802	9.91 763	9	49	
12	9.74 980	19	9.83 225	27	10.16 775	9.91 755	8	48	
13	9.74 999	19	9.83 252	27	10.16 748	9.91 746	9	47	
14	9.75 017	18	9.83 280	28	10.16 720	9.91 738	8	46	
15	9.75 036	19	9.83 307	27	10.16 693	9.91 729	9	45	
16	9.75 054	18	9.83 334	27	10.16 666	9.91 720	9	44	
17	9.75 073	19	9.83 361	27	10.16 639	9.91 712	8	43	
18	9.75 091	18	9.83 388	27	10.16 612	9.91 703	9	42	
19	9.75 110	19	9.83 415	27	10.16 585	9.91 695	8	41	
20	9.75 128	18	9.83 442	27	10.16 558	9.91 686	9	**40**	
21	9.75 147	19	9.83 470	28	10.16 530	9.91 677	9	39	
22	9.75 165	18	9.83 497	27	10.16 503	9.91 669	8	38	
23	9.75 184	19	9.83 524	27	10.16 476	9.91 660	9	37	
24	9.75 202	18	9.83 551	27	10.16 449	9.91 651	9	36	
25	9.75 221	19	9.83 578	27	10.16 422	9.91 643	8	35	
26	9.75 239	18	9.83 605	27	10.16 395	9.91 634	9	34	
27	9.75 258	19	9.83 632	27	10.16 368	9.91 625	9	33	
28	9.75 276	18	9.83 659	27	10.16 341	9.91 617	8	32	
29	9.75 294	18	9.83 686	27	10.16 314	9.91 608	9	31	
30	9.75 313	19	9.83 713	27	10.16 287	9.91 599	9	**30**	
31	9.75 331	18	9.83 740	27	10.16 260	9.91 591	8	29	
32	9.75 350	19	9.83 768	28	10.16 232	9.91 582	9	28	
33	9.75 368	18	9.83 795	27	10.16 205	9.91 573	9	27	
34	9.75 386	18	9.83 822	27	10.16 178	9.91 565	8	26	
35	9.75 405	19	9.83 849	27	10.16 151	9.91 556	9	25	
36	9.75 423	18	9.83 876	27	10.16 124	9.91 547	9	24	
37	9.75 441	18	9.83 903	27	10.16 097	9.91 538	9	23	
38	9.75 459	19	9.83 930	27	10.16 070	9.91 530	8	22	
39	9.75 478	18	9.83 957	27	10.16 043	9.91 521	9	21	
40	9.75 496	18	9.83 984	27	10.16 016	9.91 512	9	**20**	
41	9.75 514	19	9.84 011	27	10.15 989	9.91 504	8	19	
42	9.75 533	18	9.84 038	27	10.15 962	9.91 495	9	18	
43	9.75 551	18	9.84 065	27	10.15 935	9.91 486	9	17	
44	9.75 569	18	9.84 092	27	10.15 908	9.91 477	9	16	
45	9.75 587	18	9.84 119	27	10.15 881	9.91 469	8	15	
46	9.75 605	19	9.84 146	27	10.15 854	9.91 460	9	14	
47	9.75 624	18	9.84 173	27	10.15 827	9.91 451	9	13	
48	9.75 642	18	9.84 200	27	10.15 800	9.91 442	9	12	
49	9.75 660	18	9.84 227	27	10.15 773	9.91 433	9	11	
50	9.75 678	18	9.84 254	26	10.15 746	9.91 425	8	**10**	
51	9.75 696	18	9.84 280	27	10.15 720	9.91 416	9	9	
52	9.75 714	19	9.84 307	27	10.15 693	9.91 407	9	8	
53	9.75 733	18	9.84 334	27	10.15 666	9.91 398	9	7	
54	9.75 751	18	9.84 361	27	10.15 639	9.91 389	9	6	
55	9.75 769	18	9.84 388	27	10.15 612	9.91 381	8	5	
56	9.75 787	18	9.84 415	27	10.15 585	9.91 372	9	4	
57	9.75 805	18	9.84 442	27	10.15 558	9.91 363	9	3	
58	9.75 823	18	9.84 469	27	10.15 531	9.91 354	9	2	
59	9.75 841	18	9.84 496	27	10.15 504	9.91 345	9	1	
60	9.75 859		9.84 523		10.15 477	9.91 336		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	28	27	26
1	2.8	2.7	2.6
2	5.6	5.4	5.2
3	8.4	8.1	7.8
4	11.2	10.8	10.4
5	14.0	13.5	13.0
6	16.8	16.2	15.6
7	19.6	18.9	18.2
8	22.4	21.6	20.8
9	25.2	24.3	23.4

	19	18
1	1.9	1.8
2	3.8	3.6
3	5.7	5.4
4	7.6	7.2
5	9.5	9.0
6	11.4	10.8
7	13.3	12.6
8	15.2	14.4
9	17.1	16.2

	9	8
1	0.9	0.8
2	1.8	1.6
3	2.7	2.4
4	3.6	3.2
5	4.5	4.0
6	5.4	4.8
7	6.3	5.6
8	7.2	6.4
9	8.1	7.2

55°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.75 859		9.84 523		10.15 477	9.91 336		**60**	
1	9.75 877	18	9.84 550	27	10.15 450	9.91 328	8	59	
2	9.75 895	18	9.84 576	26	10.15 424	9.91 319	9	58	
3	9.75 913	18	9.84 603	27	10.15 397	9.91 310	9	57	
4	9.75 931	18	9.84 630	27	10.15 370	9.91 301	9	56	
5	9.75 949	18	9.84 657	27	10.15 343	9.91 292	9	55	
6	9.75 967	18	9.84 684	27	10.15 316	9.91 283	9	54	
7	9.75 985	18	9.84 711	27	10.15 289	9.91 274	9	53	
8	9.76 003	18	9.84 738	26	10.15 262	9.91 266	8	52	
9	9.76 021	18	9.84 764	27	10.15 236	9.91 257	9	51	
10	9.76 039	18	9.84 791	27	10.15 209	9.91 248	9	**50**	
11	9.76 057	18	9.84 818	27	10.15 182	9.91 239	9	49	
12	9.76 075	18	9.84 845	27	10.15 155	9.91 230	9	48	
13	9.76 093	18	9.84 872	27	10.15 128	9.91 221	9	47	
14	9.76 111	18	9.84 899	26	10.15 101	9.91 212	9	46	
15	9.76 129	17	9.84 925	27	10.15 075	9.91 203	9	45	
16	9.76 146	18	9.84 952	27	10.15 048	9.91 194	9	44	
17	9.76 164	18	9.84 979	27	10.15 021	9.91 185	9	43	
18	9.76 182	18	9.85 006	27	10.14 994	9.91 176	9	42	
19	9.76 200	18	9.85 033	26	10.14 967	9.91 167	9	41	
20	9.76 218	18	9.85 059	27	10.14 941	9.91 158	9	**40**	
21	9.76 236	17	9.85 086	27	10.14 914	9.91 149	8	39	
22	9.76 253	18	9.85 113	27	19.14 887	9.91 141	9	38	
23	9.76 271	18	9.85 140	26	10.14 860	9.91 132	9	37	
24	9.76 289	18	9.85 166	27	10.14 834	9.91 123	9	36	
25	9.76 307	17	9.85 193	27	10.14 807	9.91 114	9	35	
26	9.76 324	18	9.85 220	27	10.14 780	9.91 105	9	34	
27	9.76 342	18	9.85 247	26	10.14 753	9.91 096	9	33	
28	9.76 360	18	9.85 273	27	10.14 727	9.91 087	9	32	
29	9.76 378	17	9.85 300	27	10.14 700	9.91 078	9	31	
30	9.76 395	18	9.85 327	27	10.14 673	9.91 069	9	**30**	
31	9.76 413	18	9.85 354	26	10.14 646	9.91 060	9	29	
32	9.76 431	17	9.85 380	27	10.14 620	9.91 051	9	28	
33	9.76 448	18	9.85 407	27	10.14 593	9.91 042	9	27	
34	9.76 466	18	9.85 434	26	10.14 566	9.91 033	10	26	
35	9.76 484	17	9.85 460	27	10.14 540	9.91 023	9	25	
36	9.76 501	18	9.85 487	27	10.14 513	9.91 014	9	24	
37	9.76 519	18	9.85 514	26	10.14 486	9.91 005	9	23	
38	9.76 537	17	9.85 540	27	10.14 460	9.90 996	9	22	
39	9.76 554	18	9.85 567	27	10.14 433	9.90 987	9	21	
40	9.76 572	18	9.85 594	26	10.14 406	9.90 978	9	**20**	
41	9.76 590	17	9.85 620	27	10.14 380	9.90 969	9	19	
42	9.76 607	18	9.85 647	27	10.14 353	9.90 960	9	18	
43	9.76 625	17	9.85 674	26	10.14 326	9.90 951	9	17	
44	9.76 642	18	9.85 700	27	10.14 300	9.90 942	9	16	
45	9.76 660	17	9.85 727	27	10.14 273	9.90 933	9	15	
46	9.76 677	18	9.85 754	26	10.14 246	9.90 924	9	14	
47	9.76 695	17	9.85 780	27	10.14 220	9.90 915	9	13	
48	9.76 712	18	9.85 807	27	10.14 193	9.90 906	10	12	
49	9.76 730	17	9.85 834	26	10.14 166	9.90 896	9	11	
50	9.76 747	18	9.85 860	27	10.14 140	9.90 887	9	**10**	
51	9.76 765	17	9.85 887	26	10.14 113	9.90 878	9	9	
52	9.76 782	18	9.85 913	27	10.14 087	9.90 869	9	8	
53	9.76 800	17	9.85 940	27	10.14 060	9.90 860	9	7	
54	9.76 817	18	9.85 967	26	10.14 033	9.90 851	9	6	
55	9.76 835	17	9.85 993	27	10.14 007	9.90 842	10	5	
56	9.76 852	18	9.86 020	26	10.13 980	9.90 832	9	4	
57	9.76 870	17	9.86 046	27	10.13 954	9.90 823	9	3	
58	9.76 887	17	9.86 073	27	10.13 927	9.90 814	9	2	
59	9.76 904	18	9.86 100	26	10.13 900	9.90 805	9	1	
60	9.76 922		9.86 126		10.13 874	9.90 796		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	27	26
1	2.7	2.6
2	5.4	5.2
3	8.1	7.8
4	10.8	10.4
5	13.5	13.0
6	16.2	15.6
7	18.9	18.2
8	21.6	20.8
9	24.3	23.4

	18	17
1	1.8	1.7
2	3.6	3.4
3	5.4	5.1
4	7.2	6.8
5	9.0	8.5
6	10.8	10.2
7	12.6	11.9
8	14.4	13.6
9	16.2	15.3

	10	9	8
1	1.0	0.9	0.8
2	2.0	1.8	1.6
3	3.0	2.7	2.4
4	4.0	3.6	3.2
5	5.0	4.5	4.0
6	6.0	5.4	4.8
7	7.0	6.3	5.6
8	8.0	7.2	6.4
9	9.0	8.1	7.2

TABLE II

36°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.76 922		9.86 126		10.13 874	9.90 796		**60**	
1	9.76 939	17	9.86 153	27	10.13 847	9.90 787	9	59	
2	9.76 957	18	9.86 179	26	10.13 821	9.90 777	10	58	
3	9.76 974	17	9.86 206	27	10.13 794	9.90 768	9	57	
4	9.76 991	17	9.86 232	26	10.13 768	9.90 759	9	56	
5	9.77 009	18	9.86 259	27	10.13 741	9.90 750	9	55	
6	9.77 026	17	9.86 285	26	10.13 715	9.90 741	9	54	
7	9.77 043	17	9.86 312	27	10.13 688	9.90 731	10	53	
8	9.77 061	18	9.86 338	26	10.13 662	9.90 722	9	52	
9	9.77 078	17	9.86 365	27	10.13 635	9.90 713	9	51	
10	9.77 095	17	9.86 392	26	10.13 608	9.90 704	9	**50**	
11	9.77 112	17	9.86 418	27	10.13 582	9.90 694	10	49	
12	9.77 130	18	9.86 445	26	10.13 555	9.90 685	9	48	
13	9.77 147	17	9.86 471	27	10.13 529	9.90 676	9	47	
14	9.77 164	17	9.86 498	26	10.13 502	9.90 667	9	46	
15	9.77 181	17	9.86 524	27	10.13 476	9.90 657	10	45	
16	9.77 199	18	9.86 551	26	10.13 449	9.90 648	9	44	
17	9.77 216	17	9.86 577	26	10.13 423	9.90 639	9	43	
18	9.77 233	17	9.86 603	27	10.13 397	9.90 630	9	42	
19	9.77 250	17	9.86 630	26	10.13 370	9.90 620	10	41	
20	9.77 268	18	9.86 656	27	10.13 344	9.90 611	9	**40**	
21	9.77 285	17	9.86 683	26	10.13 317	9.90 602	9	39	
22	9.77 302	17	9.86 709	27	10.13 291	9.90 592	10	38	
23	9.77 319	17	9.86 736	26	10.13 264	9.90 583	9	37	
24	9.77 336	17	9.86 762	27	10.13 238	9.90 574	9	36	
25	9.77 353	17	9.86 789	26	10.13 211	9.90 565	9	35	
26	9.77 370	17	9.86 815	27	10.13 185	9.90 555	10	34	
27	9.77 387	18	9.86 842	26	10.13 158	9.90 546	9	33	
28	9.77 405	17	9.86 868	26	10.13 132	9.90 537	9	32	
29	9.77 422	17	9.86 894	27	10.13 106	9.90 527	10	31	
30	9.77 439	17	9.86 921	26	10.13 079	9.90 518	9	**30**	
31	9.77 456	17	9.86 947	27	10.13 053	9.90 509	9	29	
32	9.77 473	17	9.86 974	26	10.13 026	9.90 499	10	28	
33	9.77 490	17	9.87 000	27	10.13 000	9.90 490	9	27	
34	9.77 507	17	9.87 027	26	10.12 973	9.90 480	10	26	
35	9.77 524	17	9.87 053	26	10.12 947	9.90 471	9	25	
36	9.77 541	17	9.87 079	27	10.12 921	9.90 462	9	24	
37	9.77 558	17	9.87 106	26	10.12 894	9.90 452	10	23	
38	9.77 575	17	9.87 132	26	10.12 868	9.90 443	9	22	
39	9.77 592	17	9.87 158	27	10.12 842	9.90 434	9	21	
40	9.77 609	17	9.87 185	26	10.12 815	9.90 424	10	**20**	
41	9.77 626	17	9.87 211	27	10.12 789	9.90 415	9	19	
42	9.77 643	17	9.87 238	26	10.12 762	9.90 405	10	18	
43	9.77 660	17	9.87 264	26	10.12 736	9.90 396	9	17	
44	9.77 677	17	9.87 290	27	10.12 710	9.90 386	10	16	
45	9.77 694	17	9.87 317	26	10.12 683	9.90 377	9	15	
46	9.77 711	17	9.87 343	26	10.12 657	9.90 368	9	14	
47	9.77 728	16	9.87 369	27	10.12 631	9.90 358	10	13	
48	9.77 744	17	9.87 396	26	10.12 604	9.90 349	9	12	
49	9.77 761	17	9.87 422	26	10.12 578	9.90 339	10	11	
50	9.77 778	17	9.87 448	27	10.12 552	9.90 330	9	**10**	
51	9.77 795	17	9.87 475	26	10.12 525	9.90 320	10	9	
52	9.77 812	17	9.87 501	26	10.12 499	9.90 311	9	8	
53	9.77 829	17	9.87 527	27	10.12 473	9.90 301	10	7	
54	9.77 846	16	9.87 554	26	10.12 446	9.90 292	9	6	
55	9.77 862	17	9.87 580	26	10.12 420	9.90 282	10	5	
56	9.77 879	17	9.87 606	27	10.12 394	9.90 273	9	4	
57	9.77 896	17	9.87 633	26	10.12 367	9.90 263	10	3	
58	9.77 913	17	9.87 659	26	10.12 341	9.90 254	9	2	
59	9.77 930	16	9.87 685	26	10.12 315	9.90 244	10	1	
60	9.77 946		9.87 711		10.12 289	9.90 235	9	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	27	26
1	2.7	2.6
2	5.4	5.2
3	8.1	7.8
4	10.8	10.4
5	13.5	13.0
6	16.2	15.6
7	18.9	18.2
8	21.6	20.8
9	24.3	23.4

	18	17	16
1	1.8	1.7	1.6
2	3.6	3.4	3.2
3	5.4	5.1	4.8
4	7.2	6.8	6.4
5	9.0	8.5	8.0
6	10.8	10.2	9.6
7	12.6	11.9	11.2
8	14.4	13.6	12.8
9	16.2	15.3	14.4

	10	9
1	1.0	0.9
2	2.0	1.8
3	3.0	2.7
4	4.0	3.6
5	5.0	4.5
6	6.0	5.4
7	7.0	6.3
8	8.0	7.2
9	9.0	8.1

53°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.77 946		9.87 711		10.12 289	9.90 235		60	
1	9.77 963	17	9.87 738	27	10.12 262	9.90 225	10	59	
2	9.77 980	17	9.87 764	26	10.12 236	9.90 216	9	58	
3	9.77 997	17	9.87 790	26	10.12 210	9.90 206	10	57	
4	9.78 013	16	9.87 817	27	10.12 183	9.90 197	9	56	
5	9.78 030	17	9.87 843	26	10.12 157	9.90 187	10	55	
6	9.78 047	17	9.87 869	26	10.12 131	9.90 178	9	54	
7	9.78 063	16	9.87 895	26	10.12 105	9.90 168	10	53	
8	9.78 080	17	9.87 922	27	10.12 078	9.90 159	9	52	
9	9.78 097	17	9.87 948	26	10.12 052	9.90 149	10	51	
10	9.78 113	16	9.87 974	26	10.12 026	9.90 139	10	50	
11	9.78 130	17	9.88 000	26	10.12 000	9.90 130	9	49	
12	9.78 147	17	9.88 027	27	10.11 973	9.90 120	10	48	
13	9.78 163	16	9.88 053	26	10.11 947	9.90 111	9	47	
14	9.78 180	17	9.88 079	26	10.11 921	9.90 101	10	46	
15	9.78 197	17	9.88 105	26	10.11 895	9.90 091	10	45	
16	9.78 213	16	9.88 131	26	10.11 869	9.90 082	9	44	
17	9.78 230	17	9.88 158	27	10.11 842	9.90 072	10	43	
18	9.78 246	16	9.88 184	26	10.11 816	9.90 063	9	42	
19	9.78 263	17	9.88 210	26	10.11 790	9.90 053	10	41	
20	9.78 280	17	9.88 236	26	10.11 764	9.90 043	10	40	
21	9.78 296	16	9.88 262	26	10.11 738	9.90 034	9	39	
22	9.78 313	17	9.88 289	27	10.11 711	9.90 024	10	38	
23	9.78 329	16	9.88 315	26	10.11 685	9.90 014	10	37	
24	9.78 346	17	9.88 341	26	10.11 659	9.90 005	9	36	
25	9.78 362	16	9.88 367	26	10.11 633	9.89 995	10	35	
26	9.78 379	17	9.88 393	26	10.11 607	9.89 985	10	34	
27	9.78 395	16	9.88 420	27	10.11 580	9.89 976	9	33	
28	9.78 412	17	9.88 446	26	10.11 554	9.89 966	10	32	
29	9.78 428	16	9.88 472	26	10.11 528	9.89 956	10	31	
30	9.78 445	17	9.88 498	26	10.11 502	9.89 947	9	30	
31	9.78 461	16	9.88 524	26	10.11 476	9.89 937	10	29	
32	9.78 478	17	9.88 550	27	10.11 450	9.89 927	10	28	
33	9.78 494	16	9.88 577	26	10.11 423	9.89 918	9	27	
34	9.78 510	16	9.88 603	26	10.11 397	9.89 908	10	26	
35	9.78 527	17	9.88 629	26	10.11 371	9.89 898	10	25	
36	9.78 543	16	9.88 655	26	10.11 345	9.89 888	10	24	
37	9.78 560	17	9.88 681	26	10.11 319	9.89 879	9	23	
38	9.78 576	16	9.88 707	26	10.11 293	9.89 869	10	22	
39	9.78 592	16	9.88 733	26	10.11 267	9.89 859	10	21	
40	9.78 609	17	9.88 759	26	10.11 241	9.89 849	10	20	
41	9.78 625	16	9.88 786	27	10.11 214	9.89 840	9	19	
42	9.78 642	17	9.88 812	26	10.11 188	9.89 830	10	18	
43	9.78 658	16	9.88 838	26	10.11 162	9.89 820	10	17	
44	9.78 674	16	9.88 864	26	10.11 136	9.89 810	10	16	
45	9.78 691	17	9.88 890	26	10.11 110	9.89 801	9	15	
46	9.78 707	16	9.88 916	26	10.11 084	9.89 791	10	14	
47	9.78 723	16	9.88 942	26	10.11 058	9.89 781	10	13	
48	9.78 739	17	9.88 968	26	10.11 032	9.89 771	10	12	
49	9.78 756	16	9.88 994	26	10.11 006	9.89 761	10	11	
50	9.78 772	16	9.89 020	26	10.10 980	9.89 752	9	10	
51	9.78 788	17	9.89 046	27	10.10 954	9.89 742	10	9	
52	9.78 805	16	9.89 073	26	10.10 927	9.89 732	10	8	
53	9.78 821	16	9.89 099	26	10.10 901	9.89 722	10	7	
54	9.78 837	16	9.89 125	26	10.10 875	9.89 712	10	6	
55	9.78 853	16	9.89 151	26	10.10 849	9.89 702	9	5	
56	9.78 869	17	9.89 177	26	10.10 823	9.89 693	10	4	
57	9.78 886	16	9.89 203	26	10.10 797	9.89 683	10	3	
58	9.78 902	16	9.89 229	26	10.10 771	9.89 673	10	2	
59	9.78 918	16	9.89 255	26	10.10 745	9.89 663	10	1	
60	9.78 934		9.89 281		10.10 719	9.89 653		0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	27	26
1	2.7	2.6
2	5.4	5.2
3	8.1	7.8
4	10.8	10.4
5	13.5	13.0
6	16.2	15.6
7	18.9	18.2
8	21.6	20.8
9	24.3	23.4

	17	16
1	1.7	1.6
2	3.4	3.2
3	5.1	4.8
4	6.8	6.4
5	8.5	8.0
6	10.2	9.6
7	11.9	11.2
8	13.6	12.8
9	15.3	14.4

	10	9
1	1.0	0.9
2	2.0	1.8
3	3.0	2.7
4	4.0	3.6
5	5.0	4.5
6	6.0	5.4
7	7.0	6.3
8	8.0	7.2
9	9.0	8.1

TABLE II

38°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.78 934		9.89 281		10.10 719	9.89 653		**60**	
1	9.78 950	16	9.89 307	26	10.10 693	9.89 643	10	59	
2	9.78 967	17	9.89 333	26	10.10 667	9.89 633	10	58	
3	9.78 983	16	9.89 359	26	10.10 641	9.89 624	9	57	
4	9.78 999	16	9.89 385	26	10.10 615	9.89 614	10	56	
5	9.79 015	16	9.89 411	26	10.10 589	9.89 604	10	55	
6	9.79 031	16	9.89 437	26	10.10 563	9.89 594	10	54	
7	9.79 047	16	9.89 463	26	10.10 537	9.89 584	10	53	
8	9.79 063	16	9.89 489	26	10.10 511	9.89 574	10	52	
9	9.79 079	16	9.89 515	26	10.10 485	9.89 564	10	51	
10	9.79 095	16	9.89 541	26	10.10 459	9.89 554	10	**50**	
11	9.79 111	17	9.89 567	26	10.10 433	9.89 544	10	49	
12	9.79 128	16	9.89 593	26	10.10 407	9.89 534	10	48	
13	9.79 144	16	9.89 619	26	10.10 381	9.89 524	10	47	
14	9.79 160	16	9.89 645	26	10.10 355	9.89 514	10	46	
15	9.79 176	16	9.89 671	26	10.10 329	9.89 504	9	45	
16	9.79 192	16	9.89 697	26	10.10 303	9.89 495	10	44	
17	9.79 208	16	9.89 723	26	10.10 277	9.89 485	10	43	
18	9.79 224	16	9.89 749	26	10.10 251	9.89 475	10	42	
19	9.79 240	16	9.89 775	26	10.10 225	9.89 465	10	41	
20	9.79 256	16	9.89 801	26	10.10 199	9.89 455	10	**40**	
21	9.79 272	16	9.89 827	26	10.10 173	9.89 445	10	39	
22	9.79 288	16	9.89 853	26	10.10 147	9.89 435	10	38	
23	9.79 304	15	9.89 879	26	10.10 121	9.89 425	10	37	
24	9.79 319	16	9.89 905	26	10.10 095	9.89 415	10	36	
25	9.79 335	16	9.89 931	26	10.10 069	9.89 405	10	35	
26	9.79 351	16	9.89 957	26	10.10 043	9.89 395	10	34	
27	9.79 367	16	9.89 983	26	10.10 017	9.89 385	10	33	
28	9.79 383	16	9.90 009	26	10.09 991	9.89 375	11	32	
29	9.79 399	16	9.90 035	26	10.09 965	9.89 364	10	31	
30	9.79 415	16	9.90 061	25	10.09 939	9.89 354	10	**30**	
31	9.79 431	16	9.90 086	26	10.09 914	9.89 344	10	29	
32	9.79 447	16	9.90 112	26	10.09 888	9.89 334	10	28	
33	9.79 463	15	9.90 138	26	10.09 862	9.89 324	10	27	
34	9.79 478	16	9.90 164	26	10.09 836	9.89 314	10	26	
35	9.79 494	16	9.90 190	26	10.09 810	9.89 304	10	25	
36	9.79 510	16	9.90 216	26	10.09 784	9.89 294	10	24	
37	9.79 526	16	9.90 242	26	10.09 758	9.89 284	10	23	
38	9.79 542	16	9.90 268	26	10.09 732	9.89 274	10	22	
39	9.79 558	15	9.90 294	26	10.09 706	9.89 264	10	21	
40	9.79 573	16	9.90 320	26	10.09 680	9.89 254	10	**20**	
41	9.79 589	16	9.90 346	25	10.09 654	9.89 244	11	19	
42	9.79 605	16	9.90 371	26	10.09 629	9.89 233	10	18	
43	9.79 621	15	9.90 397	26	10.09 603	9.89 223	10	17	
44	9.79 636	16	9.90 423	26	10.09 577	9.89 213	10	16	
45	9.79 652	16	9.90 449	26	10.09 551	9.89 203	10	15	
46	9.79 668	16	9.90 475	26	10.09 525	9.89 193	10	14	
47	9.79 684	15	9.90 501	26	10.09 499	9.89 183	10	13	
48	9.79 699	16	9.90 527	26	10.09 473	9.89 173	11	12	
49	9.79 715	16	9.90 553	25	10.09 447	9.89 162	10	11	
50	9.79 731	15	9.90 578	26	10.09 422	9.89 152	10	**10**	
51	9.79 746	16	9.90 604	26	10.09 396	9.89 142	10	9	
52	9.79 762	16	9.90 630	26	10.09 370	9.89 132	10	8	
53	9.79 778	15	9.90 656	26	10.09 344	9.89 122	10	7	
54	9.79 793	16	9.90 682	26	10.09 318	9.89 112	11	6	
55	9.79 809	16	9.90 708	26	10.09 292	9.89 101	10	5	
56	9.79 825	15	9.90 734	25	10.09 266	9.89 091	10	4	
57	9.79 840	16	9.90 759	26	10.09 241	9.89 081	10	3	
58	9.79 856	16	9.90 785	26	10.09 215	9.89 071	11	2	
59	9.79 872	15	9.90 811	26	10.09 189	9.89 060	10	1	
60	9.79 887		9.90 837		10.09 163	9.89 050		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	17	16	15
1	1.7	1.6	1.5
2	3.4	3.2	3.0
3	5.1	4.8	4.5
4	6.8	6.4	6.0
5	8.5	8.0	7.5
6	10.2	9.6	9.0
7	11.9	11.2	10.5
8	13.6	12.8	12.0
9	15.3	14.4	13.5

	11	10	9
1	1.1	1.0	0.9
2	2.2	2.0	1.8
3	3.3	3.0	2.7
4	4.4	4.0	3.6
5	5.5	5.0	4.5
6	6.6	6.0	5.4
7	7.7	7.0	6.3
8	8.8	8.0	7.2
9	9.9	9.0	8.1

51°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.79 887		9.90 837		10.09 163	9.89 050		**60**	
1	9.79 903	16	9.90 863	26	10.09 137	9.89 040	10	59	
2	9.79 918	15	9.90 889	26	10.09 111	9.89 030	10	58	
3	9.79 934	16	9.90 914	25	10.09 086	9.89 020	10	57	
4	9.79 950	16	9.90 940	26	10.09 060	9.89 009	11	56	
5	9.79 965	15	9.90 966	26	10.09 034	9.88 999	10	55	
6	9.79 981	16	9.90 992	26	10.09 008	9.88 989	10	54	
7	9.79 996	15	9.91 018	26	10.08 982	9.88 978	11	53	
8	9.80 012	16	9.91 043	25	10.08 957	9.88 968	10	52	
9	9.80 027	15	9.91 069	26	10.08 931	9.88 958	10	51	
10	9.80 043	16	9.91 095	26	10.08 905	9.88 948	10	**50**	
11	9.80 058	15	9.91 121	26	10.08 879	9.88 937	11	49	
12	9.80 074	16	9.91 147	26	10.08 853	9.88 927	10	48	
13	9.80 089	15	9.91 172	25	10.08 828	9.88 917	10	47	
14	9.80 105	16	9.91 198	26	10.08 802	9.88 906	11	46	
15	9.80 120	15	9.91 224	26	10.08 776	9.88 896	10	45	
16	9.80 136	16	9.91 250	26	10.08 750	9.88 886	10	44	
17	9.80 151	15	9.91 276	26	10.08 724	9.88 875	11	43	
18	9.80 166	15	9.91 301	25	10.08 699	9.88 865	10	42	
19	9.80 182	16	9.91 327	26	10.08 673	9.88 855	10	41	
20	9.80 197	15	9.91 353	26	10.08 647	9.88 844	11	**40**	
21	9.80 213	16	9.91 379	26	10.08 621	9.88 834	10	39	
22	9.80 228	15	9.91 404	25	10.08 596	9.88 824	10	38	
23	9.80 244	16	9.91 430	26	10.08 570	9.88 813	11	37	
24	9.80 259	15	9.91 456	26	10.08 544	9.88 803	10	36	
25	9.80 274	15	9.91 482	26	10.08 518	9.88 793	10	35	
26	9.80 290	16	9.91 507	25	10.08 493	9.88 782	11	34	
27	9.80 305	15	9.91 533	26	10.08 467	9.88 772	10	33	
28	9.80 320	15	9.91 559	26	10.08 441	9.88 761	11	32	
29	9.80 336	16	9.91 585	26	10.08 415	9.88 751	10	31	
30	9.80 351	15	9.91 610	25	10.08 390	9.88 741	10	**30**	
31	9.80 366	15	9.91 636	26	10.08 364	9.88 730	11	29	
32	9.80 382	16	9.91 662	26	10.08 338	9.88 720	10	28	
33	9.80 397	15	9.91 688	26	10.08 312	9.88 709	11	27	
34	9.80 412	15	9.91 713	25	10.08 287	9.88 699	10	26	
35	9.80 428	16	9.91 739	26	10.08 261	9.88 688	11	25	
36	9.80 443	15	9.91 765	26	10.08 235	9.88 678	10	24	
37	9.80 458	15	9.91 791	26	10.08 209	9.88 668	10	23	
38	9.80 473	15	9.91 816	25	10.08 184	9.88 657	11	22	
39	9.80 489	16	9.91 842	26	10.08 158	9.88 647	10	21	
40	9.80 504	15	9.91 868	26	10.08 132	9.88 636	11	**20**	
41	9.80 519	15	9.91 893	25	10.08 107	9.88 626	10	19	
42	9.80 534	15	9.91 919	26	10.08 081	9.88 615	11	18	
43	9.80 550	16	9.91 945	26	10.08 055	9.88 605	10	17	
44	9.80 565	15	9.91 971	26	10.08 029	9.88 594	11	16	
45	9.80 580	15	9.91 996	25	10.08 004	9.88 584	10	15	
46	9.80 595	15	9.92 022	26	10.07 978	9.88 573	11	14	
47	9.80 610	15	9.92 048	26	10.07 952	9.88 563	10	13	
48	9.80 625	15	9.92 073	25	10.07 927	9.88 552	11	12	
49	9.80 641	16	9.92 099	26	10.07 901	9.88 542	10	11	
50	9.80 656	15	9.92 125	26	10.07 875	9.88 531	11	**10**	
51	9.80 671	15	9.92 150	25	10.07 850	9.88 521	10	9	
52	9.80 686	15	9.92 176	26	10.07 824	9.88 510	11	8	
53	9.80 701	15	9.92 202	26	10.07 798	9.88 499	11	7	
54	9.80 716	15	9.92 227	25	10.07 773	9.88 489	10	6	
55	9.80 731	15	9.92 253	26	10.07 747	9.88 478	11	5	
56	9.80 746	15	9.92 279	26	10.07 721	9.88 468	10	4	
57	9.80 762	16	9.92 304	25	10.07 696	9.88 457	11	3	
58	9.80 777	15	9.92 330	26	10.07 670	9.88 447	10	2	
59	9.80 792	15	9.92 356	26	10.07 644	9.88 436	11	1	
60	9.80 807	15	9.92 381	25	10.07 619	9.88 425	11	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	16	15
1	1.6	1.5
2	3.2	3.0
3	4.8	4.5
4	6.4	6.0
5	8.0	7.5
6	9.6	9.0
7	11.2	10.5
8	12.8	12.0
9	14.4	13.5

	11	10
1	1.1	1.0
2	2.2	2.0
3	3.3	3.0
4	4.4	4.0
5	5.5	5.0
6	6.6	6.0
7	7.7	7.0
8	8.8	8.0
9	9.9	9.0

TABLE II

40°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.80 807		9.92 381		10.07 619	9.88 425		60	
1	9.80 822	15	9.92 407	26	10.07 593	9.88 415	10	59	
2	9.80 837	15	9.92 433	26	10.07 567	9.88 404	11	58	
3	9.80 852	15	9.92 458	25	10.07 542	9.88 394	10	57	
4	9.80 867	15	9.92 484	26	10.07 516	9.88 383	11	56	
5	9.80 882	15	9.92 510	26	10.07 490	9.88 372	11	55	
6	9.80 897	15	9.92 535	25	10.07 465	9.88 362	10	54	
7	9.80 912	15	9.92 561	26	10.07 439	9.88 351	11	53	
8	9.80 927	15	9.92 587	26	10.07 413	9.88 340	11	52	
9	9.80 942	15	9.92 612	25	10.07 388	9.88 330	10	51	
10	9.80 957	15	9.92 638	26	10.07 362	9.88 319	11	50	
11	9.80 972	15	9.92 663	25	10.07 337	9.88 308	11	49	
12	9.80 987	15	9.92 689	26	10.07 311	9.88 298	10	48	
13	9.81 002	15	9.92 715	26	10.07 285	9.88 287	11	47	
14	9.81 017	15	9.92 740	25	10.07 260	9.88 276	11	46	
15	9.81 032	15	9.92 766	26	10.07 234	9.88 266	10	45	
16	9.81 047	14	9.92 792	26	10.07 208	9.88 255	11	44	
17	9.81 061	15	9.92 817	25	10.07 183	9.88 244	11	43	
18	9.81 076	15	9.92 843	26	10.07 157	9.88 234	10	42	
19	9.81 091	15	9.92 868	25	10.07 132	9.88 223	11	41	
20	9.81 106	15	9.92 894	26	10.07 106	9.88 212	11	40	
21	9.81 121	15	9.92 920	26	10.07 080	9.88 201	11	39	
22	9.81 136	15	9.92 945	25	10.07 055	9.88 191	10	38	
23	9.81 151	15	9.92 971	26	10.07 029	9.88 180	11	37	
24	9.81 166	14	9.92 996	25	10.07 004	9.88 169	11	36	
25	9.81 180	15	9.93 022	26	10.06 978	9.88 158	11	35	
26	9.81 195	15	9.93 048	26	10.06 952	9.88 148	10	34	
27	9.81 210	15	9.93 073	25	10.06 927	9.88 137	11	33	
28	9.81 225	15	9.93 099	26	10.06 901	9.88 126	11	32	
29	9.81 240	14	9.93 124	25	10.06 876	9.88 115	11	31	
30	9.81 254	15	9.93 150	26	10.06 850	9.88 105	10	30	
31	9.81 269	15	9.93 175	25	10.06 825	9.88 094	11	29	
32	9.81 284	15	9.93 201	26	10.06 799	9.88 083	11	28	
33	9.81 299	15	9.93 227	26	10.06 773	9.88 072	11	27	
34	9.81 314	14	9.93 252	25	10.06 748	9.88 061	11	26	
35	9.81 328	15	9.93 278	26	10.06 722	9.88 051	10	25	
36	9.81 343	15	9.93 303	25	10.06 697	9.88 040	11	24	
37	9.81 358	15	9.93 329	26	10.06 671	9.88 029	11	23	
38	9.81 372	14	9.93 354	25	10.06 646	9.88 018	11	22	
39	9.81 387	15	9.93 380	26	10.06 620	9.88 007	11	21	
40	9.81 402	15	9.93 406	26	10.06 594	9.87 996	11	20	
41	9.81 417	14	9.93 431	25	10.06 569	9.87 985	11	19	
42	9.81 431	15	9.93 457	26	10.06 543	9.87 975	10	18	
43	9.81 446	15	9.93 482	25	10.06 518	9.87 964	11	17	
44	9.81 461	14	9.93 508	26	10.06 492	9.87 953	11	16	
45	9.81 475	15	9.93 533	25	10.06 467	9.87 942	11	15	
46	9.81 490	15	9.93 559	26	10.06 441	9.87 931	11	14	
47	9.81 505	14	9.93 584	25	10.06 416	9.87 920	11	13	
48	9.81 519	15	9.93 610	26	10.06 390	9.87 909	11	12	
49	9.81 534	15	9.93 636	26	10.06 364	9.87 898	11	11	
50	9.81 549	14	9.93 661	25	10.06 339	9.87 887	11	10	
51	9.81 563	15	9.93 687	26	10.06 313	9.87 877	10	9	
52	9.81 578	14	9.93 712	25	10.06 288	9.87 866	11	8	
53	9.81 592	15	9.93 738	26	10.06 262	9.87 855	11	7	
54	9.81 607	15	9.93 763	25	10.06 237	9.87 844	11	6	
55	9.81 622	14	9.93 789	26	10.06 211	9.87 833	11	5	
56	9.81 636	15	9.93 814	25	10.06 186	9.87 822	11	4	
57	9.81 651	14	9.93 840	26	10.06 160	9.87 811	11	3	
58	9.81 665	15	9.93 865	25	10.06 135	9.87 800	11	2	
59	9.81 680	14	9.93 891	26	10.06 109	9.87 789	11	1	
60	9.81 694		9.93 916	25	10.06 084	9.87 778		0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	15	14
1	1.5	1.4
2	3.0	2.8
3	4.5	4.2
4	6.0	5.6
5	7.5	7.0
6	9.0	8.4
7	10.5	9.8
8	12.0	11.2
9	13.5	12.6

	11	10
1	1.1	1.0
2	2.2	2.0
3	3.3	3.0
4	4.4	4.0
5	5.5	5.0
6	6.6	6.0
7	7.7	7.0
8	8.8	8.0
9	9.9	9.0

49°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d	′
0	9.81 694		9.93 916		10.06 084	9.87 778		**60**
1	9.81 709	15	9.93 942	26	10.06 058	9.87 767	11	59
2	9.81 723	14	9.93 967	25	10.06 033	9.87 756	11	58
3	9.81 738	15	9.93 993	26	10.06 007	9.87 745	11	57
4	9.81 752	14	9.94 018	25	10.05 982	9.87 734	11	56
5	9.81 767	15	9.94 044	26	10.05 956	9.87 723	11	55
6	9.81 781	14	9.94 069	25	10.05 931	9.87 712	11	54
7	9.81 796	15	9.94 095	26	10.05 905	9.87 701	11	53
8	9.81 810	14	9.94 120	25	10.05 880	9.87 690	11	52
9	9.81 825	15	9.94 146	26	10.05 854	9.87 679	11	51
10	9.81 839	14	9.94 171	25	10.05 829	9.87 668	11	**50**
11	9.81 854	15	9.94 197	26	10.05 803	9.87 657	11	49
12	9.81 868	14	9.94 222	25	10.05 778	9.87 646	11	48
13	9.81 882	14	9.94 248	26	10.05 752	9.87 635	11	47
14	9.81 897	15	9.94 273	25	10.05 727	9.87 624	11	46
15	9.81 911	14	9.94 299	26	10.05 701	9.87 613	12	45
16	9.81 926	15	9.94 324	25	10.05 676	9.87 601	11	44
17	9.81 940	14	9.94 350	26	10.05 650	9.87 590	11	43
18	9.81 955	15	9.94 375	25	10.05 625	9.87 579	11	42
19	9.81 969	14	9.94 401	26	10.05 599	9.87 568	11	41
20	9.81 983	14	9.94 426	25	10.05 574	9.87 557	11	**40**
21	9.81 998	15	9.94 452	26	10.05 548	9.87 546	11	39
22	9.82 012	14	9.94 477	25	10.05 523	9.87 535	11	38
23	9.82 026	14	9.94 503	26	10.05 497	9.87 524	11	37
24	9.82 041	15	9.94 528	25	10.05 472	9.87 513	12	36
25	9.82 055	14	9.94 554	26	10.05 446	9.87 501	11	35
26	9.82 069	14	9.94 579	25	10.05 421	9.87 490	11	34
27	9.82 084	15	9.94 604	25	10.05 396	9.87 479	11	33
28	9.82 098	14	9.94 630	26	10.05 370	9.87 468	11	32
29	9.82 112	14	9.94 655	25	10.05 345	9.87 457	11	31
30	9.82 126	14	9.94 681	26	10.05 319	9.87 446	12	**30**
31	9.82 141	15	9.94 706	25	10.05 294	9.87 434	11	29
32	9.82 155	14	9.94 732	26	10.05 268	9.87 423	11	28
33	9.82 169	14	9.94 757	25	10.05 243	9.87 412	11	27
34	9.82 184	15	9.94 783	26	10.05 217	9.87 401	11	26
35	9.82 198	14	9.94 808	25	10.05 192	9.87 390	12	25
36	9.82 212	14	9.94 834	26	10.05 166	9.87 378	11	24
37	9.82 226	14	9.94 859	25	10.05 141	9.87 367	11	23
38	9.82 240	15	9.94 884	25	10.05 116	9.87 356	11	22
39	9.82 255	14	9.94 910	26	10.05 090	9.87 345	11	21
40	9.82 269	14	9.94 935	25	10.05 065	9.87 334	12	**20**
41	9.82 283	14	9.94 961	26	10.05 039	9.87 322	11	19
42	9.82 297	14	9.94 986	25	10.05 014	9.87 311	11	18
43	9.82 311	15	9.95 012	26	10.04 988	9.87 300	12	17
44	9.82 326	14	9.95 037	25	10.04 963	9.87 288	11	16
45	9.82 340	14	9.95 062	25	10.04 938	9.87 277	11	15
46	9.82 354	14	9.95 088	26	10.04 912	9.87 266	11	14
47	9.82 368	14	9.95 113	25	10.04 887	9.87 255	12	13
48	9.82 382	14	9.95 139	26	10.04 861	9.87 243	11	12
49	9.82 396	14	9.95 164	25	10.04 836	9.87 232	11	11
50	9.82 410	14	9.95 190	26	10.04 810	9.87 221	12	**10**
51	9.82 424	15	9.95 215	25	10.04 785	9.87 209	11	9
52	9.82 439	14	9.95 240	25	10.04 760	9.87 198	11	8
53	9.82 453	14	9.95 266	26	10.04 734	9.87 187	12	7
54	9.82 467	14	9.95 291	25	10.04 709	9.87 175	11	6
55	9.82 481	14	9.95 317	26	10.04 683	9.87 164	11	5
56	9.82 495	14	9.95 342	25	10.04 658	9.87 153	12	4
57	9.82 509	14	9.95 368	26	10.04 632	9.87 141	11	3
58	9.82 523	14	9.95 393	25	10.04 607	9.87 130	11	2
59	9.82 537	14	9.95 418	25	10.04 582	9.87 119	12	1
60	9.82 551		9.95 444	26	10.04 556	9.87 107		**0**
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′

Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	15	14
1	1.5	1.4
2	3.0	2.8
3	4.5	4.2
4	6.0	5.6
5	7.5	7.0
6	9.0	8.4
7	10.5	9.8
8	12.0	11.2
9	13.5	12.6

	12	11
1	1.2	1.1
2	2.4	2.2
3	3.6	3.3
4	4.8	4.4
5	6.0	5.5
6	7.2	6.6
7	8.4	7.7
8	9.6	8.8
9	10.8	9.9

TABLE II

42°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.82 551		9.95 444		10.04 556	9.87 107		**60**	
1	9.82 565	14	9.95 469	25	10.04 531	9.87 096	11	59	
2	9.82 579	14	9.95 495	26	10.04 505	9.87 085	11	58	
3	9.82 593	14	9.95 520	25	10.04 480	9.87 073	12	57	
4	9.82 607	14	9.95 545	25	10.04 455	9.87 062	11	56	
5	9.82 621	14	9.95 571	26	10.04 429	9.87 050	12	55	
6	9.82 635	14	9.95 596	25	10.04 404	9.87 039	11	54	
7	9.82 649	14	9.95 622	26	10.04 378	9.87 028	11	53	
8	9.82 663	14	9.95 647	25	10.04 353	9.87 016	12	52	
9	9.82 677	14	9.95 672	25	10.04 328	9.87 005	11	51	
10	9.82 691	14	9.95 698	26	10.04 302	9.86 993	12	**50**	
11	9.82 705	14	9.95 723	25	10.04 277	9.86 982	11	49	
12	9.82 719	14	9.95 748	25	10.04 252	9.86 970	12	48	
13	9.82 733	14	9.95 774	26	10.04 226	9.86 959	11	47	
14	9.82 747	14	9.95 799	25	10.04 201	9.86 947	12	46	
15	9.82 761	14	9.95 825	26	10.04 175	9.86 936	11	45	
16	9.82 775	14	9.95 850	25	10.04 150	9.86 924	12	44	
17	9.82 788	13	9.95 875	25	10.04 125	9.86 913	11	43	
18	9.82 802	14	9.95 901	26	10.04 099	9.86 902	11	42	
19	9.82 816	14	9.95 926	25	10.04 074	9.86 890	12	41	
20	9.82 830	14	9.95 952	26	10.04 048	9.86 879	11	**40**	
21	9.82 844	14	9.95 977	25	10.04 023	9.86 867	12	39	
22	9.82 858	14	9.96 002	25	10.03 998	9.86 855	12	38	
23	9.82 872	14	9.96 028	26	10.03 972	9.86 844	11	37	
24	9.82 885	13	9.96 053	25	10.03 947	9.86 832	12	36	
25	9.82 899	14	9.96 078	25	10.03 922	9.86 821	11	35	
26	9.82 913	14	9.96 104	26	10.03 896	9.86 809	12	34	
27	9.82 927	14	9.96 129	25	10.03 871	9.86 798	11	33	
28	9.82 941	14	9.96 155	26	10.03 845	9.86 786	12	32	
29	9.82 955	14	9.96 180	25	10.03 820	9.86 775	11	31	
30	9.82 968	13	9.96 205	25	10.03 795	9.86 763	12	**30**	
31	9.82 982	14	9.96 231	26	10.03 769	9.86 752	11	29	
32	9.82 996	14	9.96 256	25	10.03 744	9.86 740	12	28	
33	9.83 010	14	9.96 281	25	10.03 719	9.86 728	12	27	
34	9.83 023	13	9.96 307	26	10.03 693	9.86 717	11	26	
35	9.83 037	14	9.96 332	25	10.03 668	9.86 705	12	25	
36	9.83 051	14	9.96 357	25	10.03 643	9.86 694	11	24	
37	9.83 065	14	9.96 383	26	10.03 617	9.86 682	12	23	
38	9.83 078	13	9.96 408	25	10.03 592	9.86 670	12	22	
39	9.83 092	14	9.96 433	25	10.03 567	9.86 659	11	21	
40	9.83 106	14	9.96 459	26	10.03 541	9.86 647	12	**20**	
41	9.83 120	14	9.96 484	25	10.03 516	9.86 635	12	19	
42	9.83 133	13	9.96 510	26	10.03 490	9.86 624	11	18	
43	9.83 147	14	9.96 535	25	10.03 465	9.86 612	12	17	
44	9.83 161	14	9.96 560	25	10.03 440	9.86 600	12	16	
45	9.83 174	13	9.96 586	26	10.03 414	9.86 589	11	15	
46	9.83 188	14	9.96 611	25	10.03 389	9.86 577	12	14	
47	9.83 202	14	9.96 636	25	10.03 364	9.86 565	12	13	
48	9.83 215	13	9.96 662	26	10.03 338	9.86 554	11	12	
49	9.83 229	14	9.96 687	25	10.03 313	9.86 542	12	11	
50	9.83 242	13	9.96 712	25	10.03 288	9.86 530	12	**10**	
51	9.83 256	14	9.96 738	26	10.03 262	9.86 518	12	9	
52	9.83 270	14	9.96 763	25	10.03 237	9.86 507	11	8	
53	9.83 283	13	9.96 788	25	10.03 212	9.86 495	12	7	
54	9.83 297	14	9.96 814	26	10.03 186	9.86 483	12	6	
55	9.83 310	13	9.96 839	25	10.03 161	9.86 472	11	5	
56	9.83 324	14	9.96 864	25	10.03 136	9.86 460	12	4	
57	9.83 338	14	9.96 890	26	10.03 110	9.86 448	12	3	
58	9.83 351	13	9.96 915	25	10.03 085	9.86 436	12	2	
59	9.83 365	14	9.96 940	25	10.03 060	9.86 425	11	1	
60	9.83 378	13	9.96 966	26	10.03 034	9.86 413	12	**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	14	13
1	1.4	1.3
2	2.8	2.6
3	4.2	3.9
4	5.6	5.2
5	7.0	6.5
6	8.4	7.8
7	9.8	9.1
8	11.2	10.4
9	12.6	11.7

	12	11
1	1.2	1.1
2	2.4	2.2
3	3.6	3.3
4	4.8	4.4
5	6.0	5.5
6	7.2	6.6
7	8.4	7.7
8	9.6	8.8
9	10.8	9.9

47°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.83 378		9.96 966		10.03 034	9.86 413		60	
1	9.83 392	14	9.96 991	25	10.03 009	9.86 401	12	59	
2	9.83 405	13	9.97 016	25	10.02 984	9.86 389	12	58	
3	9.83 419	14	9.97 042	26	10.02 958	9.86 377	12	57	
4	9.83 432	13	9.97 067	25	10.02 933	9.86 366	11	56	
5	9.83 446	14	9.97 092	25	10.02 908	9.86 354	12	55	
6	9.83 459	13	9.97 118	26	10.02 882	9.86 342	12	54	
7	9.83 473	14	9.97 143	25	10.02 857	9.86 330	12	53	
8	9.83 486	13	9.97 168	25	10.02 832	9.86 318	12	52	
9	9.83 500	14	9.97 193	25	10.02 807	9.86 306	12	51	
10	9.83 513	13	9.97 219	26	10.02 781	9.86 295	11	50	
11	9.83 527	14	9.97 244	25	10.02 756	9.86 283	12	49	
12	9.83 540	13	9.97 269	25	10.02 731	9.86 271	12	48	
13	9.83 554	14	9.97 295	26	10.02 705	9.86 259	12	47	
14	9.83 567	13	9.97 320	25	10.02 680	9.86 247	12	46	
15	9.83 581	14	9.97 345	25	10.02 655	9.86 235	12	45	
16	9.83 594	13	9.97 371	26	10.02 629	9.86 223	12	44	
17	9.83 608	14	9.97 396	25	10.02 604	9.86 211	11	43	
18	9.83 621	13	9.97 421	25	10.02 579	9.86 200	12	42	
19	9.83 634	13	9.97 447	26	10.02 553	9.86 188	12	41	
20	9.83 648	14	9.97 472	25	10.02 528	9.86 176	12	40	
21	9.83 661	13	9.97 497	25	10.02 503	9.86 164	12	39	
22	9.83 674	13	9.97 523	26	10.02 477	9.86 152	12	38	
23	9.83 688	14	9.97 548	25	10.02 452	9.86 140	12	37	
24	9.83 701	13	9.97 573	25	10.02 427	9.86 128	12	36	
25	9.83 715	14	9.97 598	25	10.02 402	9.86 116	12	35	
26	9.83 728	13	9.97 624	26	10.02 376	9.86 104	12	34	
27	9.83 741	13	9.97 649	25	10.02 351	9.86 092	12	33	
28	9.83 755	14	9.97 674	25	10.02 326	9.86 080	12	32	
29	9.83 768	13	9.97 700	26	10.02 300	9.86 068	12	31	
30	9.83 781	13	9.97 725	25	10.02 275	9.86 056	12	30	
31	9.83 795	14	9.97 750	25	10.02 250	9.86 044	12	29	
32	9.83 808	13	9.97 776	26	10.02 224	9.86 032	12	28	
33	9.83 821	13	9.97 801	25	10.02 199	9.86 020	12	27	
34	9.83 834	13	9.97 826	25	10.02 174	9.86 008	12	26	
35	9.83 848	14	9.97 851	25	10.02 149	9.85 996	12	25	
36	9.83 861	13	9.97 877	26	10.02 123	9.85 984	12	24	
37	9.83 874	13	9.97 902	25	10.02 098	9.85 972	12	23	
38	9.83 887	13	9.97 927	25	10.02 073	9.85 960	12	22	
39	9.83 901	14	9.97 953	26	10.02 047	9.85 948	12	21	
40	9.83 914	13	9.97 978	25	10.02 022	9.85 936	12	20	
41	9.83 927	13	9.98 003	25	10.01 997	9.85 924	12	19	
42	9.83 940	13	9.98 029	26	10.01 971	9.85 912	12	18	
43	9.83 954	14	9.98 054	25	10.01 946	9.85 900	12	17	
44	9.83 967	13	9.98 079	25	10.01 921	9.85 888	12	16	
45	9.83 980	13	9.98 104	26	10.01 896	9.85 876	12	15	
46	9.83 993	13	9.98 130	25	10.01 870	9.85 864	13	14	
47	9.84 006	14	9.98 155	25	10.01 845	9.85 851	13	13	
48	9.84 020	13	9.98 180	26	10.01 820	9.85 839	12	12	
49	9.84 033	13	9.98 206	25	10.01 794	9.85 827	12	11	
50	9.84 046	13	9.98 231	25	10.01 769	9.85 815	12	10	
51	9.84 059	13	9.98 256	25	10.01 744	9.85 803	12	9	
52	9.84 072	13	9.98 281	26	10.01 719	9.85 791	12	8	
53	9.84 085	13	9.98 307	25	10.01 693	9.85 779	13	7	
54	9.84 098	14	9.98 332	25	10.01 668	9.85 766	12	6	
55	9.84 112	13	9.98 357	26	10.01 643	9.85 754	12	5	
56	9.84 125	13	9.98 383	25	10.01 617	9.85 742	12	4	
57	9.84 138	13	9.98 408	25	10.01 592	9.85 730	12	3	
58	9.84 151	13	9.98 433	25	10.01 567	9.85 718	12	2	
59	9.84 164	13	9.98 458	26	10.01 542	9.85 706	13	1	
60	9.84 177		9.98 484		10.01 516	9.85 693		0	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	14	13
1	1.4	1.3
2	2.8	2.6
3	4.2	3.9
4	5.6	5.2
5	7.0	6.5
6	8.4	7.8
7	9.8	9.1
8	11.2	10.4
9	12.6	11.7

	12	11
1	1.2	1.1
2	2.4	2.2
3	3.6	3.3
4	4.8	4.4
5	6.0	5.5
6	7.2	6.6
7	8.4	7.7
8	9.6	8.8
9	10.8	9.9

TABLE II

44°

′	L Sin	d	L Tan	c d	L Cot	L Cos	d		Prop. Pts.
0	9.84 177		9.98 484		10.01 516	9.85 693		**60**	
1	9.84 190	13	9.98 509	25	10.01 491	9.85 681	12	59	
2	9.84 203	13	9.98 534	25	10.01 466	9.85 669	12	58	
3	9.84 216	13	9.98 560	26	10.01 440	9.85 657	12	57	
4	9.84 229	13	9.98 585	25	10.01 415	9.85 645	12	56	
5	9.84 242	13	9.98 610	25	10.01 390	9.85 632	13	55	
6	9.84 255	13	9.98 635	25	10.01 365	9.85 620	12	54	
7	9.84 269	14	9.98 661	26	10.01 339	9.85 608	12	53	
8	9.84 282	13	9.98 686	25	10.01 314	9.85 596	12	52	
9	9.84 295	13	9.98 711	25	10.01 289	9.85 583	13	51	
10	9.84 308	13	9.98 737	26	10.01 263	9.85 571	12	**50**	
11	9.84 321	13	9.98 762	25	10.01 238	9.85 559	12	49	
12	9.84 334	13	9.98 787	25	10.01 213	9.85 547	12	48	
13	9.84 347	13	9.98 812	25	10.01 188	9.85 534	13	47	
14	9.84 360	13	9.98 838	26	10.01 162	9.85 522	12	46	
15	9.84 373	13	9.98 863	25	10.01 137	9.85 510	12	45	
16	9.84 385	12	9.98 888	25	10.01 112	9.85 497	13	44	
17	9.84 398	13	9.98 913	25	10.01 087	9.85 485	12	43	
18	9.84 411	13	9.98 939	26	10.01 061	9.85 473	12	42	
19	9.84 424	13	9.98 964	25	10.01 036	9.85 460	13	41	
20	9.84 437	13	9.98 989	25	10.01 011	9.85 448	12	**40**	
21	9.84 450	13	9.99 015	26	10.00 985	9.85 436	12	39	
22	9.84 463	13	9.99 040	25	10.00 960	9.85 423	13	38	
23	9.84 476	13	9.99 065	25	10.00 935	9.85 411	12	37	
24	9.84 489	13	9.99 090	25	10.00 910	9.85 399	12	36	
25	9.84 502	13	9.99 116	26	10.00 884	9.85 386	13	35	
26	9.84 515	13	9.99 141	25	10.00 859	9.85 374	12	34	
27	9.84 528	12	9.99 166	25	10.00 834	9.85 361	13	33	
28	9.84 540	13	9.99 191	25	10.00 809	9.85 349	12	32	
29	9.84 553	13	9.99 217	26	10.00 783	9.85 337	12	31	
30	9.84 566	13	9.99 242	25	10.00 758	9.85 324	13	**30**	
31	9.84 579	13	9.99 267	25	10.00 733	9.85 312	12	29	
32	9.84 592	13	9.99 293	26	10.00 707	9.85 299	13	28	
33	9.84 605	13	9.99 318	25	10.00 682	9.85 287	12	27	
34	9.84 618	12	9.99 343	25	10.00 657	9.85 274	13	26	
35	9.84 630	13	9.99 368	25	10.00 632	9.85 262	12	25	
36	9.84 643	13	9.99 394	26	10.00 606	9.85 250	12	24	
37	9.84 656	13	9.99 419	25	10.00 581	9.85 237	13	23	
38	9.84 669	13	9.99 444	25	10.00 556	9.85 225	12	22	
39	9.84 682	12	9.99 469	25	10.00 531	9.85 212	13	21	
40	9.84 694	13	9.99 495	26	10.00 505	9.85 200	12	**20**	
41	9.84 707	13	9.99 520	25	10.00 480	9.85 187	13	19	
42	9.84 720	13	9.99 545	25	10.00 455	9.85 175	12	18	
43	9.84 733	12	9.99 570	25	10.00 430	9.85 162	13	17	
44	9.84 745	13	9.99 596	26	10.00 404	9.85 150	12	16	
45	9.84 758	13	9.99 621	25	10.00 379	9.85 137	13	15	
46	9.84 771	13	9.99 646	25	10.00 354	9.85 125	12	14	
47	9.84 784	12	9.99 672	26	10.00 328	9.85 112	13	13	
48	9.84 796	13	9.99 697	25	10.00 303	9.85 100	12	12	
49	9.84 809	13	9.99 722	25	10.00 278	9.85 087	13	11	
50	9.84 822	13	9.99 747	26	10.00 253	9.85 074	13	**10**	
51	9.84 835	12	9.99 773	25	10.00 227	9.85 062	12	9	
52	9.84 847	13	9.99 798	25	10.00 202	9.85 049	13	8	
53	9.84 860	13	9.99 823	25	10.00 177	9.85 037	12	7	
54	9.84 873	12	9.99 848	26	10.00 152	9.85 024	13	6	
55	9.84 885	13	9.99 874	25	10.00 126	9.85 012	12	5	
56	9.84 898	13	9.99 899	25	10.00 101	9.84 999	13	4	
57	9.84 911	12	9.99 924	25	10.00 076	9.84 986	13	3	
58	9.84 923	13	9.99 949	26	10.00 051	9.84 974	12	2	
59	9.84 936	13	9.99 975	25	10.00 025	9.84 961	12	1	
60	9.84 949		10.00 000		10.00 000	9.84 949		**0**	
	L Cos	d	L Cot	c d	L Tan	L Sin	d	′	Prop. Pts.

	26	25
1	2.6	2.5
2	5.2	5.0
3	7.8	7.5
4	10.4	10.0
5	13.0	12.5
6	15.6	15.0
7	18.2	17.5
8	20.8	20.0
9	23.4	22.5

	14	13	12
1	1.4	1.3	1.2
2	2.8	2.6	2.4
3	4.2	3.9	3.6
4	5.6	5.2	4.8
5	7.0	6.5	6.0
6	8.4	7.8	7.2
7	9.8	9.1	8.4
8	11.2	10.4	9.6
9	12.6	11.7	10.8

45°

APPENDIX

II

Distances	Measured	Calculated
AB	27.166	27.167 ←
AC	26.021	invisible
AD	28.144	28.143
BD		invisible
BC		17.359
CD		26.08

Added ∠s

△ ABC

38° 1'

74° 33'

67° 24'

179° 58' ck

△ ACD

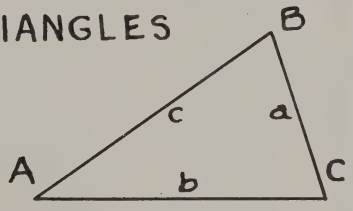
57° 26'

65° 25'

57° 14'

179° 65 ck.

SOLUTION OF OBLIQUE TRIANGLES

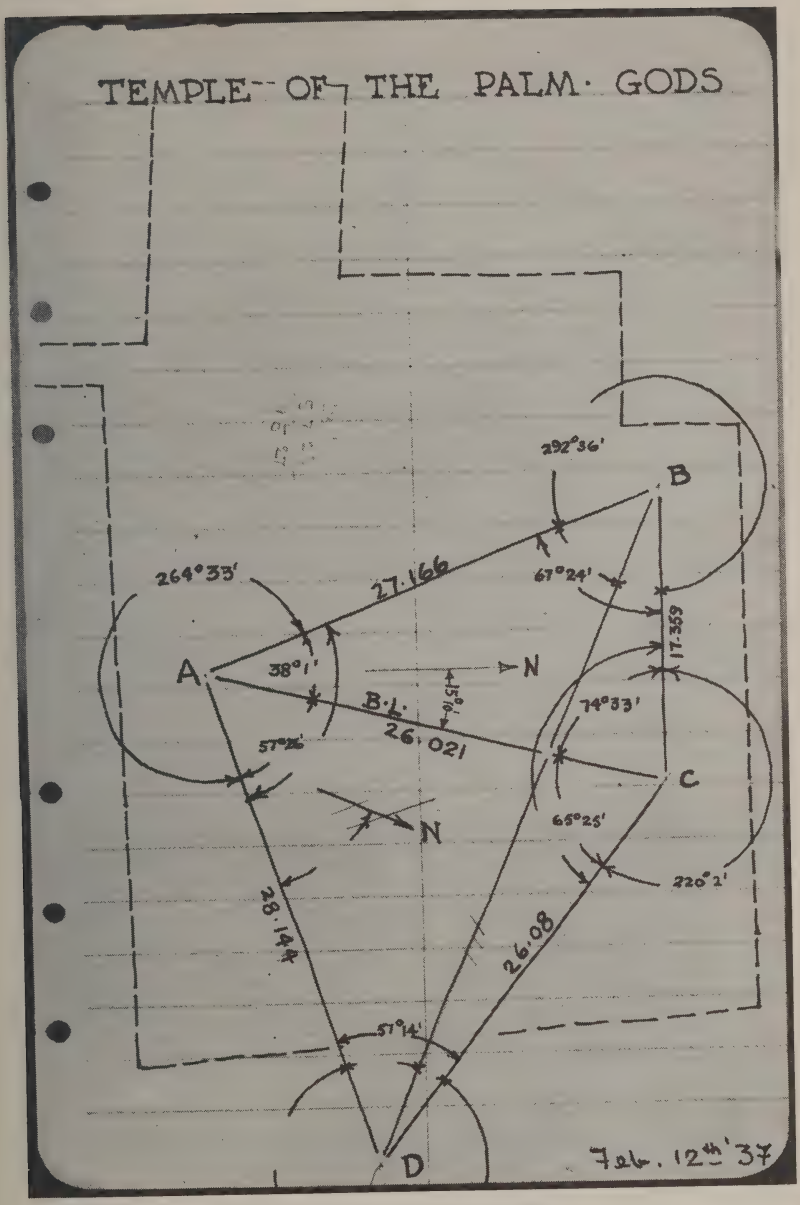


GIVEN	SOUGHT	FORMULAS
A,B,a	b,c	$b=\frac{a}{\sin A}\sin B$
		$c=\frac{a}{\sin A}\sin(A+B)$
A,a,b	B,c	$\sin B\frac{\sin A}{a}$ B
		$c=\frac{a}{\sin A}\sin C$

SPECIMEN SHEET FROM FIELD BOOK WITH RESULTS OF CALCULATIONS. PERTINENT TRIG. FORMULAS INSERTED.

No.	Back Sight	Fore Sight	Reduced Level	Description of Point
81	✓	2.94	-0.13	H8, early foundation, top
82	✓	3.08	-0.27	Doorway J6-J8, sill
83	✓	1.77	+1.04	J8, beam holes, east wall
84	✓	1.31	+1.50	Doorway St-H1, sill
85	✓	1.54	+1.27	" St-S1, "
86	✓	1.74	+1.07	" St-S2, "
87	✓	1.72	+1.09	" St-S3, "
88	✓	1.74	+1.07	" St-S4 "
89	✓	.83	+1.98	Wall H8-D2, top
90	✓	3.25	-0.44	D7, Bed-rock, south
91	✓	2.85	-0.04	D7, stair, step 7
92	✓	1.47	+1.34	D7, stair, step 5
93	✓	2.99	-0.18	D2, brick paving, north east
94	✓	2.74	+0.07	D2, stair, step 1
95	✓	1.32	+1.49	D2, stair, step 7
96	✓	2.59	+0.22	Doorway D2-D4, sill
97	✓	2.82	-0.01	" D2-D3, "
98	✓	0.86	+1.95	Wall D2-D7, top
99	✓	0.55	+2.26	" D3-St., top
100	✓	2.77	+0.04	Doorway D2-D7, sill

SPECIMEN SHEET FROM FIELD LEVEL BOOK.



SPECIMEN SHEET FROM FIELD BOOK WITH OBSERVATIONS AND CALCULATIONS ENTERED.

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